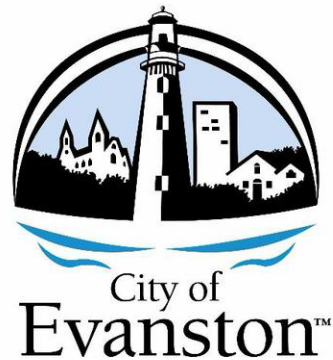


PROJECT SPECIFICATION MANUAL

VOLUME 2 OF 3



EVANSTON ANIMAL SHELTER

2310 OAKTON STREET
EVANSTON, IL 60202

ISSUE FOR BID / PERMIT

December 8, 2022

DESIGN TEAM:

HOLABIRD & ROOT

Architect / Interior Design

CONNOLLY

Architect / Consultant

TERRA ENGINEERING LTD.

Civil Engineering & Surveying

RME

Structural Engineering

SITE DESIGN GROUP

Landscape Architecture

IMEG CORP.

MEP/FP Engineering

CCS INTERNATIONAL

Cost Estimating

GSG

CONSULTANTS

Geotechnical &
Environmental Engineering

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EVANSTON ANIMAL SHELTER

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The complete Project Manual for this project consists of these entire Volumes 1, 2 and 3, which must not be separated for any reason. The Architect and Owner disclaim any responsibility for any assumptions made by a contractor or subcontractor who does not receive a complete Project Manual, including all sections listed in the Table of Contents.

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PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 21 Sections. Also refer to Division 01 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 SCOPE OF WORK

- A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.
- B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make the portion of the Mechanical Work a finished and working system.

1.3 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
 - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
 - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - d. Maintenance clearances and code-required dedicated space shall be included.
 - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.

2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
 - a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
 - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
 - a. Scale of drawings:
 - 1) General plans: 1/4 Inch = 1'-0" (minimum).
 - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
 - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
 - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
 - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).

2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
 - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
 - b. Potential layout changes shall be made to avoid additional access panels.
 - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
 - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
 - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.

12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.4 QUALITY ASSURANCE

A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers are acceptable.
2. All Contractors and subcontractors shall employ only workers skilled in their trades.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City of Evanston Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all State Codes.
3. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
4. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
5. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
6. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
7. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
7. Where applicable, all fixtures, equipment and materials shall be approved or listed by Underwriter's Laboratories, Inc..

E. Examination of Drawings:

1. The drawings for the fire protection work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
3. Scaling of the drawings is not sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
8. Where used in fire protection documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
 - a. Any item listed as furnished shall also be installed, unless otherwise noted.
 - b. Any item listed as installed shall also be furnished, unless otherwise noted.

F. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

G. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.

4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

1.5 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

Referenced Specification Section	Submittal Item
21 05 00	Owner Training Agenda
21 13 00	Sprinkler Systems
21 13 00	Fire Protection Equipment

- B. General Submittal Procedures: In addition to the provisions of Division 01, the following are required:

1. Transmittal: Each transmittal shall include the following:
 - a. Date
 - b. Project title and number
 - c. Contractor's name and address
 - d. Division of work (e.g., plumbing, heating, ventilating, etc.)
 - e. Description of items submitted and relevant specification number
 - f. Notations of deviations from the contract documents
 - g. Other pertinent data
2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
 - a. Date
 - b. Project title and number
 - c. Architect/Engineer
 - d. Contractor and subcontractors' names and addresses
 - e. Supplier and manufacturer's names and addresses
 - f. Division of work (e.g., plumbing, heating, ventilating, etc.)

- g. Description of item submitted (using project nomenclature) and relevant specification number
 - h. Notations of deviations from the contract documents
 - i. Other pertinent data
 - j. Provide space for Contractor's review stamps
3. Composition:
- a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
 - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
 - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; electrical power criteria (e.g., voltage, phase, amps, horsepower, kW, etc.) wiring and control diagrams; Short Circuit Current Rating (SCCR); dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
5. Contractor's Approval Stamp:
- a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
 - b. Unstamped submittals will be rejected.
 - c. The Contractor's review shall include, but not be limited to, verification of the following:
 - 1) Only approved manufacturers are used.
 - 2) Addenda items have been incorporated.
 - 3) Catalog numbers and options match those specified.
 - 4) Performance data matches that specified.
 - 5) Electrical characteristics and loads match those specified.
 - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
 - 7) Dimensions and service clearances are suitable for the intended location.
 - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
 - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
 - d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.

- e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
6. Submittal Identification and Markings:
 - a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
 - b. The Contractor shall clearly indicate the size, finish, material, etc.
 - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
 - d. All marks and identifications on the submittals shall be unambiguous.
 7. Schedule submittals to expedite the project. Coordinate submission of related items.
 8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
 9. Reproduction of contract documents alone is not acceptable for submittals.
 10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
 11. Submittals not required by the contract documents may be returned without review.
 12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
 13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.
 14. Contractor's responsibility for errors, omissions, or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
 15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
 - a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.
 16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.
- C. Electronic Submittal Procedures:
1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
 2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.

3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. Submittal file name: 21 XX XX.description.YYYYMMDD
 - b. Transmittal file name: 21 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.6 CHANGE ORDERS

- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.
- B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.
- C. Change order work shall not proceed until authorized.

1.7 EQUIPMENT SUPPLIERS' INSPECTION

- A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:
 1. Fire Seal Systems
- B. Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.
- C. Submit copies of start-up reports to the Architect/Engineer and include copies of Owner's Operation and Maintenance Manuals.

1.8 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.

- B. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- C. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

1.9 WARRANTY

- A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.
- B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

1.10 INSURANCE

- A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

1.11 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the scheduled manufacturer is the basis for job design and establishes the quality required.
- B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections, piping and ductwork connections and arrangement, plumbing connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.

- D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractors part or on the part of other Contractors whose work is affected.
- E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.
- F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

1.12 LEED REQUIREMENTS

- A. This project is pursuing a LEED Silver certification in accordance with USGBC LEED Rating System for New Construction v4. The Contractor shall provide all services and documentation necessary to achieve this rating.

1.13 PROJECT COMMISSIONING

- A. The Contractor shall work with the Commissioning Agent (CxA) as described in Section 01 91 00 and provide all services necessary for compliance with LEED Prerequisite EAp1, Fundamental Commissioning, and EAc3 Enhanced Commissioning.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 EXCAVATION, FILL, BACKFILL, COMPACTION

- A. General:
 - 1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found at the following website (<https://call811.com/>) or by calling 811.
 - 2. The Contractor shall do all excavating, filling, backfilling and compacting associated with the work.

B. Excavation:

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.
2. Where excavations are made in error below foundations, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer, shall be placed in such excess excavations. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
3. Trim bottom and sides of excavations to grades required for foundations.
4. Protect excavations against frost and freezing.
5. Take care in excavating not to damage surrounding structures, equipment, or buried pipe. Do not undermine footing or foundation.
6. Perform all trenching in a manner to prevent cave-ins and risk to workers.
7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
8. Where satisfactory bearing soil for foundations is not found at the indicated levels, the Architect/Engineer or their representative shall be notified immediately, and no further work shall be done until further instructions are given by the Architect/Engineer or their representative.

C. Dewatering:

1. Contractor shall furnish, install, operate, and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.

D. Underground Obstructions:

1. Known underground piping, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Use great care in making installations near underground obstruction.
2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.

E. Fill and Backfilling:

1. No rubbish or waste material is permitted for fill or backfill.
2. Provide all necessary sand and/or CA6 for backfilling.
3. Native soil materials may be used as backfill if approved by the Geotechnical Engineer.
4. Dispose of the excess excavated earth as directed.
5. Backfill materials (native soil material, sand and/or CA6) shall be suitable for required compaction, clean and free of perishable materials and stones greater than 4 inches (100 mm) in diameter. Water shall not be permitted to rise in unbackfilled trenches. No material shall be used for backfilling that contains frozen earth, debris, or earth with a high void content.
6. Backfill all trenches and excavations immediately after installing pipes or removal of forms, unless other protection is provided.
7. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Fill and backfill materials shall be spread in 6 inch uniform horizontal layers with each layer compacted separately to required density.

8. Lay all piping on a compacted bed of CA6 at least 3 inches deep. Backfill around pipes with CA6, 6 inch layers, and compact each layer.
9. Use native soil material (if approved), sand, or CA6 for backfill up to grade for all piping under slabs or paved areas. All other piping shall have sand or CA6 backfill to 6 inches above the top of the pipe.
10. Place all backfill above the sand/CA6 in uniform layers not exceeding 6 inches deep. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement.
11. Where the fill and backfill will ultimately be under a building, floor or paving, each layer of fill shall be compacted to 95% of the maximum density determined by AASHTO Designation T-99 or ASTM Designation D-698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content determined by AASHTO T-99 or ASTM D-698 test.

F. Surface Restoration:

1. Where trenches are cut through graded, planted, or landscaped areas, the areas shall be restored to the original condition. Replace all planting removed or damaged to its original condition. A minimum of 6 inches of topsoil shall be applied where disturbed areas are to be seeded or sodded.
2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition.

3.3 ARCHITECT/ENGINEER OBSERVATION OF WORK

A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Placing fill over underground and underslab utilities.
 2. Covering exterior walls, interior partitions and chases.
 3. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
 - a. Pipe wall penetrations are sealed.
 - b. Pipe identification is installed.
 - c. Branch piping in the location of sprinklers shall be dropped to the ceiling.
2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

3.4 PROJECT CLOSEOUT

- A. The following paragraphs supplement the requirements of Division 01.
- B. Final Jobsite Observation:
 - 1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
 - 2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.
 - 3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
 - 4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.
- C. Before final payment is authorized, this Contractor must submit the following:
 - 1. Operation and maintenance manuals with copies of approved shop drawings.
 - 2. Record documents including reproducible drawings and specifications.
 - 3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
 - 4. Inspection report by the State Fire Marshal of the fire protection system.
 - 5. Start-up reports on all equipment requiring a factory installation inspection or start-up.
- 6. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site; receipt by Architect/Engineer required prior to final payment approval.

3.5 OPERATION AND MAINTENANCE MANUALS

- A. General:
 - 1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
 - 2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.
- B. Electronic Submittal Procedures:
 - 1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
 - 2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.

3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
 4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. O&M file name: O&M.div21.contractor.YYYYMMDD
 - b. Transmittal file name: O&Mtransmittal.div21.contractor.YYYYMMDD
 5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
 6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
 7. All text shall be searchable.
 8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.
- C. Operation and Maintenance Instructions shall include:
1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
 2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
 3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
 4. Copy of final approved test and balance reports.
 5. Copies of all factory inspections and/or equipment startup reports.
 6. Copies of warranties.
 7. Schematic electrical power/controls wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
 8. Dimensional drawings of equipment.
 9. Capacities and utility consumption of equipment.
 10. Detailed parts lists with lists of suppliers.
 11. Operating procedures for each system.
 12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
 13. Repair procedures for major components.
 14. List of lubricants in all equipment and recommended frequency of lubrication.
 15. Instruction books, cards, and manuals furnished with the equipment.

3.6 INSTRUCTING THE OWNER'S REPRESENTATIVES

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.
- D. The instructions shall include:
 - 1. Explanation of all system flow diagrams.
 - 2. Maintenance of equipment.
 - 3. Start-up procedures for all major equipment.
 - 4. Explanation of seasonal system changes.
 - 5. Description of emergency system operation.
- E. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can attend if desired.
- F. Minimum hours of instruction for each item shall be:
 - 1. Sprinkler System(s) - 4 hours.
- G. The Contractor shall prepare a detailed, written training agenda and submit it to the Architect/Engineer a minimum of two weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts, etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.
- H. Operating Instructions:
 - 1. Contractor is responsible for all instructions to the Owner's representatives for the fire protection and control systems.
 - 2. If the Contractor does not have staff that can adequately provide the required instructions the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.7 SYSTEM STARTING AND ADJUSTING

- A. The fire protection systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final comfort adjustments as required.

- B. Complete all manufacturer-recommended startup procedures and checklists to verify proper motor rotation, electrical power voltage is within equipment limitations, equipment controls maintain pressures and temperatures within acceptable ranges, all filters and protective guards are in-place, acceptable access is provided for maintenance and servicing, and equipment operation does not pose a danger to personnel or property.
- C. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.
- D. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.8 RECORD DOCUMENTS

- A. The following paragraphs supplement Division 01 requirements.
- B. Maintain at the job site a separate and complete set of fire protection drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.
- C. Mark drawings to indicate revisions to piping size and location, both exterior and interior; including locations of other control devices, and other units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located; Change Orders; concealed control system devices.
- D. Before completion of the project, a set of reproducible fire protection drawings will be given to the Contractor for transfer of all as-built conditions from the paper set maintained at the job site. All marks on reproducibles shall be clear and permanent.
- E. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.
- F. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.
- G. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

3.9 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.
- B. Clean all areas where moisture is present. Immediately report any mold, biological growth, or water damage.
- C. Remove all rust, scale, dirt, oils, stickers and thoroughly clean exterior of all exposed piping, hangers, and accessories.
- D. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.10 SPECIAL REQUIREMENTS

- A. Contractor shall coordinate the installation of all equipment, valves, etc., with other trades to maintain clear access area for servicing.
- B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

3.11 IAQ MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

- A. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:
 - 1. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:
 - a. Minimizing the amount of dust generated.
 - b. Reducing solvent fumes and VOC emissions.
 - c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.
 - 2. Request that the Owner designate an IAQ representative.
 - 3. Review and receive approval from the Owner's IAQ representative for all IAQ-related construction activities and negative pressure containment plans.
 - 4. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.
 - 5. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.
 - 6. Request copies of and follow all of the Owner's IAQ and infection control policies.

7. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.
8. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.
9. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings Under Construction".

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

1. Penetrations fire sealed and labeled in accordance with specifications.
3. Fire protection system operational.
4. Pipes labeled.

Accepted by:

Prime Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION

SECTION 21 0503 - THROUGH PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Through-Penetration Firestopping.

1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

1.3 REFERENCES

- A. UL 263 - Fire Tests of Building Construction and Materials
- B. UL 723 - Surface Burning Characteristics of Building Materials
- C. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
- D. UL 2079 - Tests for Fire Resistance of Building Joint Systems
- E. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
- F. Intertek / Warnock Hersey - Directory of Listed Products
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- H. 2021 International Building Code

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.
- B. Install material prior to expiration of product shelf life.

1.5 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.

1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
 2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per UL 1479:
1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
- C. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
- D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- E. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

1.6 MEETINGS

- A. Pre-installation meeting: A pre-installation meeting shall be scheduled and shall include the General Contractor, all Subcontractors associated with the installation of systems penetrating fire barriers, Firestopping Manufacturer's Representative, and the Owner.
1. Review foreseeable methods related to firestopping work.
 2. Tour representative areas where firestopping is to be installed; inspect and discuss each type of condition and each type of substrate that will be encountered, and preparation to be performed by other trades.

1.7 WARRANTY

- A. Provide one year warranty on parts and labor.
- B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.

B. Manufacturers:

1. 3M; Fire Protection Products Division.
2. Hilti, Inc.
3. RectorSeal Corporation, Metacaulk.
4. Tremco; Sealant/Weatherproofing Division.
5. Johns-Manville.
6. Specified Technologies Inc. (S.T.I.)
7. Spec Seal Firestop Products
8. AD Firebarrier Protection Systems
9. Dow Corning Corp.
10. Fire Trak Corp.
11. International Protective Coating Corp.

2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

- A. Provide materials and systems classified by or listed by Intertek / Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.
- B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.
- C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.
- D. Firestopping systems for plumbing and wet pipe sprinkler piping shall be moisture resistant.
- E. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.
- F. Provide firestopping systems allowing continuous insulation for all insulated pipes.
- G. Provide firestopping systems classified by UL or listed by Intertek / Warnock Hersey for penetrations through all fire rated construction. Firestopping systems shall be selected from the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory Category XHEZ based on substrate construction and penetrating item size and material and shall fall within the range of numbers listed:

1. Combustible Framed Floors and Chase Walls - 1 or 2 Hour Rated:
 - a. F Rating = Floor/Wall Rating

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	FC 0000-0999*
Metallic Pipe or Conduit	FC 1000-1999
Non-Metallic Pipe or Conduit	FC 2000-2999
Electrical Cables	FC 3000-3999
Cable Trays	FC 4000-4999
Insulated Pipes	FC 5000-5999
Bus Duct and Misc. Electrical	FC 6000-6999

<u>Penetrating Item</u>	<u>UL System No.</u>
Duct without Damper and Misc. Mechanical	FC 7000-7999
Multiple Penetrations	FC 8000-8999
*Alternate method of firestopping is patching opening to match original rated construction.	

2. Non-Combustible Framed Walls - 1 or 2 Hour Rated:

a. F Rating = Wall Rating

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	WL 0000-0999*
Metallic Pipe or Conduit	WL 1000-1999
Non-Metallic Pipe or Conduit	WL 2000-2999
Electrical Cables	WL 3000-3999
Cable Trays	WL 4000-4999
Insulated Pipes	WL 5000-5999
Bus Duct and Misc. Electrical	WL 6000-6999
Duct without Damper and Misc. Mechanical	WL 7000-7999
Multiple Penetrations	WL 8000-8999
*Alternate method of firestopping is patching opening to match original rated construction.	

3. Concrete or Masonry Floors and Walls - 1 or 2 Hour Rated:

a. F Rating = Wall/Floor Rating

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	CAJ 0000-0999*
Metallic Pipe or Conduit	CAJ 1000-1999
Non-Metallic Pipe or Conduit	CAJ 2000-2999
Electrical Cables	CAJ 3000-3999
Cable Trays	CAJ 4000-4999
Insulated Pipes	CAJ 5000-5999
Bus Duct and Misc. Electrical	CAJ 6000-6999
Duct without Damper and Misc. Mechanical	CAJ 7000-7999
Multiple Penetrations	CAJ 8000-8999
*Alternate method of firestopping is patching opening to match original rated construction.	

H. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.

I. Any openings in floors or walls not described in the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory, or outlined in manufacturer's information shall be sealed in a manner agreed upon by the Firestopping Manufacturer, Owner, and the Authority Having Jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.
- B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.
- C. Surfaces to which sealing materials are to be installed must meet the selected UL or Intertek / Warnock Hersey system substrate criteria.
- D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

3.2 INSTALLATION

- A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Intertek / Warnock Hersey listed firestopping system is installed.
- B. Install penetration seal materials in accordance with printed instructions of the UL or Intertek / Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.
- C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

3.3 CLEANING AND PROTECTING

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

3.4 IDENTIFICATION

- A. Provide and install labels adjacent to each firestopping location. Label shall be provided by the firestop system supplier and contain the following information in a contrasting color:
 - 1. The words "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Firestop System Supplier; UL or listed by Intertek / Warnock Hersey system number; date installed; contractor name and phone number; manufacturer's representative name, address, and phone number.

3.5 INSPECTION

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.
- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.
- D. The contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the contractor and witnessed by the engineer and manufacturer's factory representative. The engineer shall have sole discretion of which firestop system installations will be reviewed. The contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the engineer's discretion and the contractor's expense.

END OF SECTION

SECTION 21 0529 - FIRE SUPPRESSION SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Hangers, Supports, and Associated Anchors.
- B. Equipment Bases and Supports.
- C. Sleeves and Seals.
- D. Flashing and Sealing of Equipment and Pipe Stacks.
- E. Cutting of Openings.
- F. Escutcheon Plates and Trim.

1.2 QUALITY ASSURANCE

- A. Support Sprinkler Piping in conformance with NFPA 13.

1.3 REFERENCES

- A. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- B. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
- C. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- D. NFPA 13 - Standard for the Installation of Sprinkler Systems.

1.4 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

- A. Furnish sleeves and hanger inserts to General Contractor for placement into formwork.

PART 2 - PRODUCTS

2.1 HANGER RODS

- A. Hanger rods for single rod hangers supporting steel, copper, and CPVC piping shall conform to the following:

<u>Pipe Size</u>	<u>Rod Size</u>
4" and smaller	3/8"

5" 6", and 8"	1/2"
10"	5/8"
12"	3/4"

- B. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
- C. All hanger rods, nuts, washers, clevises, etc., in damp areas shall have ASTM A123 hot-dip galvanized finish applied after fabrication. This applies to the following areas:

2.2 PIPE HANGERS AND SUPPORTS

A. General:

- 1. All pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS-SP-58, 69, 89, and 127 (where applicable).

B. Hangers and Clamps:

- 1. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp.
- 2. Unless otherwise indicated, hangers shall be as follows:
 - a. Adjustable Swivel Ring Type: Service: Bare Metal Pipe - 4 inches and Smaller
 - 1) Products: Bare Steel Pipe
 - a) Anvil Fig. 69
 - b) Cooper/B-Line Fig. B3170NF
 - c) Erico Model FCN
 - d) Nibco/Tolco Fig. 200.
- 3. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.
- 4. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
- 5. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.
- 6. Unless otherwise indicated, pipe supports for use with struts shall be as follows:
 - a. Clamp Type: Service: Bare Metal Pipe, Rigid Plastic Pipe
 - 1) Clamps in direct contact with copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp.

- 2) Pipes subject to expansion and contraction shall have clamps slightly oversized to allow limited pipe movement.
- 3) Products: Bare Steel, Plastic or Insulated Pipe
 - a) Unistrut Fig. P1100 or P2500
 - b) Cooper/B-Line Fig. B2000 or B2400
 - c) Nibco/Tolco Fig. A-14 or 2STR.

C. Upper (Structural) Attachments:

1. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:
 - a. Steel Structure Clamps: C-Type Wide Flange Beam Clamps (for use on top and/or bottom of wide flanges. Not permitted for use with bar-joists.)
 - 1) Products:
 - a) Anvil Fig. 92
 - b) Cooper/B-Line Fig. B3033/B3034
 - c) Erico Model 300
 - d) Nibco/Tolco 68.
 - b. Scissor Type Beam Clamps (for use with bar-joists and wide flange):
 - 1) Products:
 - a) Anvil Fig. 228, 292
 - b) Cooper/B-Line Fig. B3054
 - c) Erico Model 360
 - d) Nibco/Tolco Fig. 329.
 - c. Concentrically Loaded Open Web Joist Hangers (for use with bar joists):
 - 1) Products:
 - a) MCL. M1, M2 or M3
 - d. Steel Structure Welding:
 - 1) Unless otherwise noted, hangers, clips, and auxiliary support steel may be welded in lieu of bolting, clamping, or riveting to the building structural frame. Take adequate precautions during all welding operations for fire prevention and for protecting walls and ceilings from being damaged by smoke.
 - e. Wood Anchors: Tension wood rod hanger for suspending 3/8" threaded rod. Zinc plated carbon steel.

- 1) Minimum allowable tension loads for Douglass Fir/Southern Pine:
 - a) 3/8" diameter rod; 2-1/2" shank: 600 lb/590 lb.
 - b) Load values are based on full shank penetration into wood member. Minimum edge distance 3/4". Minimum end distance 3-1/4".
- 2) Limitations:
 - a) Truss: Do not hang from wood trusses without truss manufacturer or Structural EngineerTMs approval.
 - b) Sheetrock/Gypsum Ceiling: When drilling through non-wood materials (e.g., sheet rock, gypsum, etc.), increase shank length by depth of non-wood materials.
 - c) Plywood Flooring/Roofing: Do not hang from plywood floor or roofing.
 - d) Spacing: Refer to wood structure spacing of hangers.
- 3) Products:
 - a) Simpson RWV
 - b) DeWALT
 - c) ITI Sammys GT25

2.3 FOUNDATIONS, BASES, AND SUPPORTS

A. Basic Requirements:

1. Furnish and install supports (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for mechanical equipment.

B. Supports:

1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.
2. Hang heavy equipment from concrete floors or ceilings with Architect-approved concrete inserts, furnished and installed by the Contractor whose work requires them, except where indicated otherwise.

2.4 OPENINGS IN FLOORS, WALLS AND CEILINGS

- A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the General Contractor for installation or construction as the structure is built.
- B. Coordinate all openings with other Contractors.

- C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.
- D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at Contractor's expense.
- E. Do not cut structural members without written approval of the Architect or Structural Engineer.

2.5 PIPE SLEEVES AND LINTELS

- A. Each Contractor shall provide pipe sleeves and lintels for all openings required for the Contractor's work in masonry walls and floors, unless specifically shown as being by others.
- B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.
- C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Architect or Structural Engineer.
- D. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
- E. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Engineer's design.
- F. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.
- G. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
- H. Where pipes rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (e.g., foam, rubber, asphalt-coated fiber, bituminous-impregnated felt, or cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
- I. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.
- J. Wall Seals ("Link-Seals"):

1. Where shown on the drawings, pipes passing through walls, ceilings, or floors shall have their annular space (sleeve or drilled hole - not tapered hole made with knockout plug) sealed by properly sized sealing elements consisting of a synthetic rubber material compounded to resist aging, ozone, sunlight, water and chemical action.
2. Sleeves, if used, shall be standard weight steel with primed finish and waterstop/anchor continuously welded to sleeve or thermoplastic with integral water seal and textured surface.
3. Sleeves shall be at least 2 pipe sizes larger than the pipes.
4. Pressure shall be maintained by stainless steel bolts and other parts. Pressure plates may be of composite material for Models S and OS.
5. Sealing element shall be as follows:

Model	Service	Element Material	Temperature Range
S	Standard (Stainless)	EPDM	-40°F to 250°F
T	Fire Seals (1 hour)	Silicone	-67°F to 400°F
FS	Fire Seals (3 hours)	Silicone	-67°F to 400°F
OS	Oil Resistant/Stainless	Nitrile	-40°F to 210°F

6. Manufacturers:
 - a. Thunderline Corporation "Link-Seals"
 - b. O-Z/Gedney Company
 - c. Calpico, Inc.
 - d. Innerlynx
 - e. Metraflex Company (cold service only).

2.6 ESCUTCHEON PLATES AND TRIM

- A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.
- B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.
- C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes duct and pipe openings.

2.7 PIPE PENETRATIONS

- A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.
- B. Seal fire rated wall and floor penetrations with fire seal system as specified.

2.8 PIPE ANCHORS

- A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.
- B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

2.9 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.1 FIRE SUPPRESSION SUPPORTS AND ANCHORS

A. General Installation Requirements:

- 1. Install all items per manufacturer's instructions.
- 2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
- 3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- 4. Supports shall extend directly to building structure. Do not support piping from duct hangers. Do not allow lighting or ceiling supports to be hung from piping supports.

B. Supports Requirements:

- 1. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
- 2. Set all concrete inserts in place before pouring concrete.
- 3. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
- 4. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
- 5. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

C. Pipe Requirements:

- 1. Support all piping and equipment, including valves, strainers, and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
- 2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.

3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
 4. Piping shall not introduce strains or distortion to connected equipment.
 5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
 6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
 7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
 8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.
- D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:
1. Loads of 100 lbs or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.
 2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
 - a. The hanger is attached within 6" from a web/chord joint.
 - b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.
 3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
 4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.
- E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.
- F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.
- H. Steel/Concrete Structure: Spacing of hangers shall in no case exceed the following:
1. Steel (All steel pipe unless otherwise noted):
 - a. Maximum Spacing:
 - 1) 1-1/4" & under: 12'-0"
 - 2) 1-1/2" & larger: 15'-0"
- I. Installation of hangers shall conform to MSS SP-58, 69, 89, and applicable NFPA standards.

City of Evanston
Evanston Animal Shelter
Holabird & Root, LLC Project No. 16015

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END OF SECTION

SECTION 21 0553 - FIRE SUPPRESSION IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Identification of products installed under Division 21.

1.2 REFERENCES

- A. ANSI/ASME A13.1 - Scheme for the Identification of Piping Systems.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. 3M
- B. Bunting
- C. Calpico
- D. Craftmark
- E. Emedco
- F. Kolbi Industries
- G. Seton
- H. W.H. Brady
- I. Marking Services.

2.2 MATERIALS

- A. All pipe markers (purchased or stenciled) shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

OD of Pipe or Insulation	Marker Length	Size of Letters
Up to and including 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
Over 10"	32"	3-1/2"

Plastic tags may be used for outside diameters under 3/4"

- B. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.
- C. Plastic Tags: Minimum 1-1/2" square or round laminated three-layer phenolic with engraved, 1/4" minimum black letters on light contrasting background.
- D. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all products per manufacturer's recommendations.
- B. Degrease and clean surfaces to receive adhesive for identification materials.
- C. Valves:
 - 1. All valves (except shutoff valves at equipment) shall have numbered tags.
 - 2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.
 - 3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.
 - 4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.
 - 5. Attach to handwheel or around valve stem. On lever operated valves, drill the lever to attach tags.
 - 6. Number all tags and show the service of the pipe.
 - 7. Provide one Plexiglas framed valve directory listing all valves, with respective tag numbers, uses and locations. Mount directory in location chosen by the Architect/Engineer.
- D. Pipe Markers:
 - 1. Snap-on Markers: Use Seton "Setmark" on pipes up to 5-7/8" OD. Use Seton "Setmark" with nylon or Velcro ties for pipes 6" OD and over. Similar styles by other listed manufacturers are acceptable.
 - 2. Apply markers and arrows in the following locations where clearly visible:
 - a. At each valve.
 - b. On both sides of walls that pipes penetrate.
 - c. At least every 20 feet along all pipes.
 - d. On each riser and each leg of each "T" joint.
 - e. At least once in every room and each story traversed.
- E. Equipment:

1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.
2. Fasten nameplates or plastic tags with stainless steel self-tapping screws or permanently bonding cement.
3. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE 90.1.

3.2 SCHEDULE

- A. Pipes to be marked shall be labeled with text shown as follows, regardless of which method or material is used:
 1. FIRE PROTECTION WATER: White lettering; red background
 2. SPRINKLER WATER: White lettering; red background
- B. All piping downstream of the fire protection backflow preventer, upstream of sprinkler zone valves, standpipe piping, and combination sprinkler standpipe piping shall be labeled Fire Protection Water. All piping downstream of sprinkler zone valves shall be labeled Sprinkler Water.

END OF SECTION

SECTION 21 1302 - FIRE PROTECTION SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe, Fittings, Valves, and Connections for Fire Protection System.
- B. Wet-Pipe Sprinkler System.

1.2 QUALITY ASSURANCE

- A. Welding Materials and Procedures: Conform to ASME Code.
- B. Equipment and Components: Bear ULlabel or marking.
- C. Valves: Bear ULlabel or marking. Provide manufacturer's name and pressure rating marked on valve body. Pressure rating shall match specified pipe system pressure rating. Remanufactured valves are not acceptable.
- D. Specialist Firm: Company specializing in sprinkler systems with minimum three years' experience.
- E. Sprinkler design drawings submitted by the Contractor shall be prepared by a NICET Water-Based Fire Protection Systems Layout Level III or Level IV designer or PE.

1.3 REFERENCES

- A. ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
- B. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings, Class 150 and 300.
- C. ANSI/ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.
- D. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.
- E. ANSI/ASME B16.9 - Factory-made Wrought Steel Butt-Welding Fittings.
- F. ANSI/ASME B16.11 - Forged Steel Fittings, Socket-Welding and Threaded.
- G. ANSI/ASME B16.25 - Butt-Welding Ends.
- H. ANSI/ASME B36.10 - Welded and Seamless Wrought Steel Pipe.
- I. ANSI/ASME Section 9 - Welding and Brazing Qualifications.
- J. ANSI/ASTM A47 - Malleable Iron Castings.

- K. ANSI/ASTM A135 - Electric-Resistance-Welded Steel Pipe.
 - L. ANSI/AWWA C110 - Ductile Iron and Gray Iron Fittings.
 - M. ANSI/AWWA C151 - Ductile Iron Pipe, Centrifugally Cast.
 - N. ASME - Boiler and Pressure Vessel Code - Section IX, Welding and Brazing Requirements.
 - O. ASTM A153 - Pipe, Steel, Black and Hot-Dipped, Zinc-coated Welded and Seamless.
 - P. AWS B2.2 - Standard for Brazing Procedure and Performance Qualification.
 - Q. AWS D10.9 - Specifications for Qualification of Welding Procedures and Welders for Piping and Tubing.
 - R. IBC - International Building Code.
 - S. MSS SP-73 - Brazing Joints for Wrought and Cast Copper Alloy Solder Joint and Pressure Fittings.
 - T. NFPA 101 - Life Safety Code,
 - U. NFPA 13 - Standard for the Installation of Sprinkler Systems.
 - V. NFPA 25 - Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
 - W. UL - Underwriter's Laboratory Fire Protection Equipment Directory.
- 1.4 SUBMITTALS
- A. Submit shop drawings per Section 21 0500. Indicate pipe materials, joining methods, supports, floor and wall penetration seals, sprinklers, equipment data and ratings, and hydraulic calculations.
 - B. Submit detailed pipe and sprinkler layout and other calculations and forms as described in NFPA 13.
 - C. Submit detailed working drawings and obtain review of them in the following order:
 - 1. Engineer/Architect/State Fire Marshal/Authority Having Jurisdiction
 - 3. Owner's Insurance Company
 - D. Working drawings shall include piping and sprinkler layout, sprinkler types and ratings, sections and elevations at critical points. Show coordination with lighting, ductwork, and diffusers, and indicate basic flow and hydraulic design information, including main location and date that the test was taken.

- E. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
 - F. Provide the Owner with one copy of NFPA 25. Standard for the Inspection Testing and Maintenance of Water-based Fire Protection Systems.
- 1.5 EXTRA STOCK
- A. Provide metal storage cabinet, wrenches for each sprinkler type, and extra sprinklers per NFPA 13 and applicable building code.
- 1.6 DELIVERY, STORAGE, AND HANDLING
- A. Store valves and sprinklers in shipping containers, with labels in place.
 - B. Provide temporary protective coating on iron and steel valves.
 - C. Maintain temporary end caps and closures in place until installation.
- 1.7 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS
- A. Furnish sleeves to General Contractor for placement in walls and floors. Sleeve location to be determined by the Fire Protection Contractor prior to construction. If additional sleeves are required, they shall be core drilled by the Fire Protection Contractor.
- 1.8 SYSTEM DESCRIPTION
- A. Contractor shall design and install the following water-based fire protection systems for the areas noted on the contract documents:
 - 1. Wet pipe sprinkler system(s)
 - B. Sprinkler systems shall be designed and installed according to the following standard(s):
 - 1. NFPA 13 - Standard for the Installation of Sprinkler Systems
 - C. System design and installation shall include all requirements by the Authority Having Jurisdiction, local and state building codes, and Owner's insurance company in addition to the previously listed design standard(s). Those requirements shall take precedence over the contract documents in the case of discrepancies.
 - D. Systems shall be hydraulically calculated in accordance with the applicable design standard(s). Contractor is responsible for final pipe sizing based on results from hydraulic calculations. Pipe sizing shown on drawings for service entrance and main risers is preliminary and for coordination purposes only.
 - E. The water supply source for this project is the following:
 - 1. Public waterworks system.

2. The system design shall be based on water supply information provided on the contract drawings. Supply shall be presumed to be at the point of connection to existing water supply infrastructure unless noted otherwise. The Fire Protection Contractor is responsible to verify this information and conduct all tests required. Base all pipe sizing and hydraulic calculations on flow test data no older than 6 months.
 3. System design shall be based on the following water supply information. Supply shall be presumed to be at the point of connection to existing water supply infrastructure unless noted otherwise. The Fire Protection Contractor is responsible to verify this information and conduct all tests required. Base all pipe sizing and hydraulic calculations on flow test data no older than 6 months.
 - a. Date of Test: 3/2/2022
 - b. Static Pressure: 43 psig
 - c. Residual Pressure: 41 psig
 - d. Flow at Residual Pressure: 944 GPM
 4. System design shall provide a safety factor when comparing available water supply pressure versus system design pressure at design flow rate (including hose streams). The safety factor shall be the following:
 - a. 5 psig
- F. Coordinate with Plumbing Contractor for installation of a standpipe with collection funnel below the backflow preventer.

1.9 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 21 0500 for required fire protection systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

1.10 OPERATION AND MAINTENANCE DATA

- A. Submit manufacturers' operation and maintenance data. Include written maintenance data on components of system, servicing requirements, and record drawings.

1.11 JOB CONDITIONS

- A. Fire Protection Contractor shall determine the flow and pressure available at the service connection. The Fire Protection Contractor is responsible to verify this information and make all tests required. Base all pipe sizing and hydraulic calculations on flow test data no older than 18 months.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS - WET PIPE SPRINKLER SYSTEMS

- A. Piping - 2" and Under (Steel Pipe):

1. Design Pressure: 175 psig
 2. Pipe: Schedule 40, black steel, ASTM A53, ASTM A795, UL. Inner wall shall be coated with an anti-MIC (microbiologically influenced corrosion) coating.
 - 3.
 4. Fittings:
 - a. Grooved:
 - 1) Ductile iron housing ASTM A-536, Grade 65-45-12, UL, enamel coating, Grade E (Type A) EPDM molded pressure-responsive gaskets suited for 40°F to 150°F. Carbon steel bolts and nuts.
- B. Piping - 2-1/2" and Above (Steel Pipe):
1. Design Pressure: 175 psig
 2. Pipe: Schedule 10, black steel, ASTM A135, ASTM A795, UL. Inner wall shall be coated with an anti-MIC (microbiologically influenced corrosion) coating.
3. Joints: Grooved.
4. Fittings:
 - a. Grooved:
 - 1) Ductile iron housing ASTM A-536, Grade 65-45-12, UL, enamel coating, Grade E (Type A) EPDM molded pressure-responsive gaskets suited for 40°F to 150°F. Carbon steel bolts and nuts.
- 2.2 FLEXIBLE FIRE SPRINKLER CONNECTIONS
- A. Flexible Connection: Stainless steel hose, 175 psig max working pressure, fully welded non-mechanical fittings, stainless steel braid, maximum of 6' hose length, leak-tested with a minimum 7/8" internal corrugated hose diameter made of 304 stainless steel, end fittings made of carbon or stainless steel. Outlet of end fittings shall be 1/2" or 3/4" to match sprinkler connection. UL.
- B. Ceiling Bracket: G90 galvanized steel, direct attachment type, integrated snap-on clip ends, tamper resistance screws, removable attachment hub with set screw for attachment and adjustment of stainless steel hose.
1. Manufacturers:
 - a. Flexhead Industries
 - b. Victaulic VicFlex,
 - c. Sprinkflex
 - d. or approved equal.

2.3 VALVES

- A. Provide handwheels for gate valves. Provide gear operators for butterfly valves.

- B. Provide all connections to match pipe joints. Valves shall be same size as pipe.

2.4 BACKFLOW PREVENTERS

- A. Provide backflow preventers as required by code and as specified on the drawings.

2.5 EQUIPMENT

- A. Equipment shall be as scheduled on the drawings.

2.6 RISER LABELING AND IDENTIFICATION

- A. Hydraulic nameplates shall be affixed to each riser and shall include the following minimum information:

1. Installation contractor
2. Date installed
3. Riser location
4. Number of sprinklers
5. Basis of design (density GPM/ft² and area of coverage ft²)
6. Water flow rate (GPM) and residual pressure (psi) at the base of riser
7. Hose stream allowance (GPM).
8. Occupancy classification
9. Commodity classification (If applicable)
10. Maximum storage height (if applicable)

2.7 PIPE LABELING AND IDENTIFICATION

- A. Provide additional identification as described in Section 21 0553.

PART 3 - EXECUTION

3.1 INSTALLATION - PIPING

- A. General Installation Requirements:

1. Coordinate piping and sprinkler locations with all other trades. Ductwork, diffusers and light fixture locations shall have priority over sprinkler piping and sprinklers.
2. Ream pipe and tube ends to full inside diameter. Remove burrs. Remove scale and foreign material, inside and outside, before assembly.
3. Die cut screw joints with full cut standard taper pipe threads.
4. Coat threads with pipe joint compound or wrap with Teflon tape.
5. Locate piping to minimize obstruction of other work.
6. Route piping in concealed spaces above finished ceiling.
7. Use full and double lengths of pipe wherever possible.
8. Slope all piping for complete drainage. Install auxiliary drains for all trapped piping per NFPA 13.

9. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.
10. Comply with manufacturer's installation instructions.

B. Steel Piping:

1. In steel piping, main sized saddle branch connections or direct connection of branches to main is permitted if main is one pipe size larger than the branch for up to 6" mains and if main is two pipe sizes larger than branch for 8" and larger mains. Do not project branch pipes into main pipes.

C. Wall/Floor Penetration:

1. Provide sleeves when penetrating floors and walls.
2. Seal pipes passing through exterior walls with a wall seal per Section 21 0529. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe. Sleeves through floors shall extend minimum 1.5" above finished floor.
3. Fire seal all pipe and sleeve penetrations (both wall and floor) to maintain fire separation required without restraining pipe.

D. Installation Requirements in Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment. Fire protection equipment dedicated to the electrical equipment room or space may be installed above equipment if other alternatives are not available.

E. Hangers and Supports:

1. Provide hangers and supports as required by NFPA 13 and UL, with the following exceptions:
 - a. Do not use powder driven devices, explosive devices, wooden plugs, or plastic inserts.
 - b. Do not install fasteners to carry the load in tension, unless absolutely necessary.

F. Exposed Piping:

1. Install chrome plated steel escutcheons where exposed pipes penetrate walls or floors.
2. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories.

3.2 INSTALLATION - VALVES

- A. Install gate valves with stems upright or horizontal, not inverted.
- B. Backflow Preventer:

1. Provide an air gap fitting and piping to drain. On 2-1/2" and larger units, install a tail piece from air gap fitting to drain to prevent water from spraying out of drain air gap receptor. Maintain air gap distance required by Code.
2. Units shall be field tested and tagged in accordance with manufacturer's instructions by a certified tester before initial operation.
3. Install unit between 12" and 60" above finish floor.
4. Provide monitor switches on all shutoff valves.

C. Shutoff Valve:

1. Install buried shutoff valves in valve boxes. Provide post indicators.
2. Provide drain valves at main shutoff valves, low points of piping and apparatus.
3. Provide monitor switches on all shutoff valves.

3.3 INSTALLATION - EQUIPMENT

A. Coordinate piping and sprinkler locations with all other trades. Ductwork, diffusers and light fixture locations shall have priority over system equipment and sprinklers.

B. Fire Department Connection:

1. Locate fire department connection in an accessible location as approved by the local fire department with sufficient clearance from walls, obstructions, and adjacent Siamese connectors to allow full swing of fire department wrench handle.

C. Alarm Bell:

1. Locate outside alarm bell on building wall as shown on drawings.
2. Wire all bells, flow switches and supervisory switches to fire alarm system. All wiring shall be in conduit and meet the requirements of the electrical specifications.

D. Test Valves:

1. Install test valves where required. Pipe to outdoors or drain. Test connection shall have flow equivalent to the smallest K-factor sprinkler.

E. Sprinklers:

1. Locate sprinklers to clear lights, ducts and diffusers. Do not run sprinkler pipes through ducts. Ductwork has priority over sprinkler pipes. Offset pipes as needed.
2. Center sprinklers in two directions in ceiling tiles and provide offsets as required.
3. Do not allow concealed sprinkler cover plates to be painted. Sprinkler cover plates are to be factory painted only. Do not field paint.
4. Apply strippable or paper covers so concealed sprinkler cover plates do not receive field paint finish.

3.4 SYSTEMS CLEANING AND TESTING

A. General Requirement:

1. All water used for testing and remaining in the piping system shall be obtained from a potable water source.
- B. Underground Piping:
1. Flush all underground piping with minimum flow equal to the system design flow but not less than the following:
 - a. 390 gpm for 4" pipes.
 - b. 880 gpm for 6" pipes.
 2. Branches from existing or new underground mains to sprinkler risers shall be flushed out through two 2-1/2" hoses (with flow through open hose butts) attached to the riser with 4" temporary piping. Flushing through the drain of an alarm check or dry pipe valve is not acceptable.
- C. Interior Piping:
1. Verify adequate water flow at the inspector's test connection.
 2. Flush all interior piping to remove scale and other foreign material before placing system into service.
 3. Hydrostatically test the entire interior piping system at a minimum of 200 psig or 50 psig more than the normal system working pressure for systems subjected to pressures more than 150 psig. Maintain test pressure for 2 hours without loss of pressure..
- D. Fire Alarm System:
1. Test the alarm system by operating the inspector's test connection or the alarm test valves. Verify that the building fire alarm system activates.
 2. Adjust all monitor switches for proper operation.

END OF SECTION

SECTION 22 0500 - BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 22 Sections. Also refer to Division 1 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 SCOPE OF WORK

- A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.
- B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make the portion of the Mechanical Work a finished and working system.

1.3 WORK SEQUENCE

- A. All work that will produce excessive noise or interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during unoccupied hours. The Owner reserves the right to determine when restricted construction hours will be required.
- B. Itemize all work and list associated hours and pay scale for each item.

1.4 COORDINATION DRAWINGS

- A. Definitions:
 - 1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
 - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
 - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.

- c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - d. Maintenance clearances and code-required dedicated space shall be included.
 - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
 2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
 - a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
 3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.
- B. Participation:
 1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
 2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
 - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
 3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.
- C. Drawing Requirements:
 1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
 - a. Scale of drawings:
 - 1) General plans: 1/4 Inch = 1'-0" (minimum).

- 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
 - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
 - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
 - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
 3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
 4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
 - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
 - b. Potential layout changes shall be made to avoid additional access panels.
 - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
 - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
 - e. When additional access panels are required, they shall be provided without additional cost to the Owner.

10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.5 QUALITY ASSURANCE

A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers are acceptable.
2. All Contractors and subcontractors shall employ only workers skilled in their trades.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City of Evanston Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all published standards of University of Illinois.
3. Conform to all State Codes.
4. Conform to Federal Act S.3874 requiring the reduction of lead in drinking water.
5. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
6. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
7. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
8. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.

9. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.
- D. Permits, Fees, Taxes, Inspections:
1. Procure all applicable permits and licenses.
 2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
 3. Pay all charges for permits or licenses.
 4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
 5. Pay all charges arising out of required inspections by an authorized body.
 6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
 7. Where applicable, all fixtures, equipment and materials shall be approved or listed by Underwriter's Laboratories, Inc.
- E. Utility Company Requirements:
1. Secure from the appropriate private or public utility company all applicable requirements.
 2. Comply with all utility company requirements.
 3. Make application for and pay for service connections, such as sewer and water.
 4. Make application for and pay for all meters and metering systems required by the utility company.
- F. Examination of Drawings:
1. The drawings for the plumbing work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
 2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
 3. Scaling of the drawings is not sufficient or accurate for determining these locations.
 4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
 5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
 6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
 7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
 8. Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
 - a. Any item listed as furnished shall also be installed, unless otherwise noted.
 - b. Any item listed as installed shall also be furnished, unless otherwise noted.

G. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

H. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

1.6 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals List:

Referenced Specification Section	Submittal Item
22 05 00	Owner Training Agenda
22 05 29	Hangers and Supports
22 10 00	Plumbing Piping Systems and Valves
22 10 30	Plumbing Specialties
22 11 23	Domestic Water Pumps
22 30 00	Plumbing Equipment
22 40 00	Plumbing Fixtures

- B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:

- a. Date
 - b. Project title and number
 - c. Contractor's name and address
 - d. Division of work (e.g., plumbing, heating, ventilating, etc.)
 - e. Description of items submitted and relevant specification number
 - f. Notations of deviations from the contract documents
 - g. Other pertinent data
2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
- a. Date
 - b. Project title and number
 - c. Architect/Engineer
 - d. Contractor and subcontractors' names and addresses
 - e. Supplier and manufacturer's names and addresses
 - f. Division of work (e.g., plumbing, heating, ventilating, etc.)
 - g. Description of item submitted (using project nomenclature) and relevant specification number
 - h. Notations of deviations from the contract documents
 - i. Other pertinent data
 - j. Provide space for Contractor's review stamps
3. Composition:
- a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
 - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
 - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; electrical power criteria (e.g., voltage, phase, amps, horsepower, kW, etc.) wiring and control diagrams; Short Circuit Current Rating (SCCR); dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
5. Contractor's Approval Stamp:
- a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
 - b. Unstamped submittals will be rejected.
 - c. The Contractor's review shall include, but not be limited to, verification of the following:

- 1) Only approved manufacturers are used.
 - 2) Addenda items have been incorporated.
 - 3) Catalog numbers and options match those specified.
 - 4) Performance data matches that specified.
 - 5) Electrical characteristics and loads match those specified.
 - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
 - 7) Dimensions and service clearances are suitable for the intended location.
 - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
 - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
- d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
- e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
6. Submittal Identification and Markings:
- a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
 - b. The Contractor shall clearly indicate the size, finish, material, etc.
 - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
 - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.

- a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.
16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.
- C. Electronic Submittal Procedures:
1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
 2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
 3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
 4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. Submittal file name: 22 XX XX.description.YYYYMMDD
 - b. Transmittal file name: 22 XX XX.description.YYYYMMDD
 5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
- 1.7 CHANGE ORDERS
- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.
 - B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.
 - C. Change order work shall not proceed until authorized.
- 1.8 EQUIPMENT SUPPLIERS' INSPECTION
- A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:
 1. Fire Seal Systems
 2. Domestic Water Booster Pump

- B. Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.
- C. Submit copies of start-up reports to the Architect/Engineer and include copies of Owner's Operation and Maintenance Manuals.

1.9 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.
- B. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- C. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

1.10 NETWORK / INTERNET CONNECTED EQUIPMENT

- A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.11 WARRANTY

- A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.
- B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

1.12 INSURANCE

- A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

1.13 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the first manufacturer is the basis for job design and establishes the quality.
- B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections, piping and ductwork connections and arrangement, plumbing connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.
- D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractor's part or on the part of other Contractors whose work is affected.
- E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.
- F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

1.14 LEED REQUIREMENTS

- A. This project is pursuing a LEED Silver certification in accordance with USGBC LEED Rating System for New Construction v4 The Contractor shall provide all services and documentation necessary to achieve this rating.
- B. The points being attempted for this project are:
 - 1. Water Efficiency - Indoor Water Use Reduction (Prerequisite)
 - 2. Water Efficiency - Indoor Water Use Reduction
 - 3. Water Efficiency - Water Metering.

1.15 PROJECT COMMISSIONING

- A. The Contractor shall work with the Commissioning Agent (CxA) as described in Section 01 91 00 and provide all services necessary for compliance with LEED Prerequisite EAp1, Fundamental Commissioning, and EAc3 Enhanced Commissioning.
- B. The Contractor shall work with the Commissioning Agent (CxA) as described in Section 01 91 00 and provide all services as described in the Commissioning Plan.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 EXCAVATION, FILL, BACKFILL, COMPACTION

A. General:

1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found at the following website (<https://call811.com/>) or by calling 811.
2. The Contractor shall do all excavating, filling, backfilling and compacting associated with the work.

B. Excavation:

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.
2. Where excavations are made in error below foundations, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer, shall be placed in such excess excavations. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
3. Trim bottom and sides of excavations to grades required for foundations.
4. Protect excavations against frost and freezing.

5. Take care in excavating not to damage surrounding structures, equipment, or buried pipe. Do not undermine footing or foundation.
 6. Perform all trenching in a manner to prevent cave-ins and risk to workers.
 7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
 8. Where satisfactory bearing soil for foundations is not found at the indicated levels, the Architect/Engineer or their representative shall be notified immediately, and no further work shall be done until further instructions are given by the Architect/Engineer or their representative.
- C. Dewatering:
1. Contractor shall furnish, install, operate, and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.
- D. Underground Obstructions:
1. Known underground piping, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Use great care in making installations near underground obstruction.
 2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.
- E. Fill and Backfilling:
1. Utilities Bedding: Lay underground utilities on minimum of 6" sand bedding or CA6 crushed stone. Compact bedding under utilities smooth, with no sharp edges protruding, to protect the utilities from puncture. Shape bedding to provide continuous support for bells, joints, and barrels of utilities and for joints and fittings.
 2. Envelope around utilities to 6" above utilities: Place and compact sand or CA6 to a height of 6" over utilities in 6" layers. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement. After connection joints are made, any misalignment can be corrected by tamping backfill around the utilities.
 3. Backfill from 6" above utilities to earthen grade: Place all backfill materials above the utilities in uniform layers not exceeding 6" deep. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement.
 4. Backfill from 6" above utilities to below slabs or paved area: Where the fill and backfill will ultimately be under a building, floor or paving, each layer of backfill materials shall be compacted to 95% of the maximum density determined by AASHTO Designation T 99 or ASTM Designation D 698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content determined by AASHTO T 99 or ASTM D 698 test.
 5. Backfill Materials: Native soil materials may be used as backfill if approved by the Geotechnical Engineer. Backfill material shall be free of rock or gravel larger than 3" in any dimension and shall be free of debris, waste, frozen materials, vegetation, high void content, and other deleterious materials. Water shall not be permitted to rise in unbackfilled trenches.
 6. Dispose of excess excavated earth as directed.

7. Backfill all trenches and excavations immediately after installing utilities or removal of forms, unless other protection is provided.
8. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Fill and backfill materials shall be spread in 6 inch uniform horizontal layers with each layer compacted separately to required density.

F. Surface Restoration:

1. Where trenches are cut through existing graded, planted, or landscaped areas, the areas shall be restored to the original condition. Replace all planting removed or damaged to its original condition. A minimum of 6 inches of topsoil shall be applied where disturbed areas are to be seeded or sodded.
2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition.

3.3 ARCHITECT/ENGINEER OBSERVATION OF WORK

A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Placing fill over underground and underslab utilities.
2. Covering exterior walls, interior partitions and chases.
3. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
 - a. Pipe insulation is installed and fully sealed.
 - b. Pipe wall penetrations are sealed.
 - c. Pipe identification and valve tags are installed.
2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

3.4 PROJECT CLOSEOUT

A. The following paragraphs supplement the requirements of Division 1.

B. Final Jobsite Observation:

1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.
3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

C. Before final payment is authorized, this Contractor must submit the following:

1. Operation and maintenance manuals with copies of approved shop drawings.
2. Record documents including reproducible drawings and specifications.
3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
4. Start-up reports on all equipment requiring a factory installation inspection or start-up.
5. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site; receipt by Architect/Engineer required prior to final payment approval.

3.5 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.

- a. O&M file name: O&M.div22.contractor.YYYYMMDD
 - b. Transmittal file name: O&Mtransmittal.div22.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
 6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
 7. All text shall be searchable.
 8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.
- C. Operation and Maintenance Instructions shall include:
1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
 2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
 3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
 4. Copy of final approved test and balance reports.
 5. Copies of all factory inspections and/or equipment startup reports.
 6. Copies of warranties.
 7. Schematic electrical power/controls wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
 8. Dimensional drawings of equipment.
 9. Capacities and utility consumption of equipment.
 10. Detailed parts lists with lists of suppliers.
 11. Operating procedures for each system.
 12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
 13. Repair procedures for major components.
 14. List of lubricants in all equipment and recommended frequency of lubrication.
 15. Instruction books, cards, and manuals furnished with the equipment.
 16. Owner and Contractor attendance list for domestic water systems operation, maintenance, and flushing training.
- 3.6 INSTRUCTING THE OWNER'S REPRESENTATIVES
- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.

- B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
 - C. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.
 - D. The instructions shall include:
 - 1. Explanation of all system flow diagrams.
 - 2. Maintenance of equipment.
 - 3. Start-up procedures for all major equipment.
 - 4. Explanation of seasonal system changes.
 - 5. Explanation of Owner's Responsibilities to operate, maintain, and flush domestic water system (i.e., ASHRAE Standard 188).
 - E. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can attend if desired.
 - F. Minimum hours of instruction for each item shall be:
 - 1. Domestic Hot Water System - 4 hours
 - 2. All Domestic Water Systems operation, maintenance and flushing of all fixtures and dead legs - 4 hours
 - 3. Domestic Water Pressure Booster System - 4 hours.
 - G. The Contractor shall prepare a detailed, written training agenda and submit it to the Architect/Engineer a minimum of two weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts, etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.
 - H. Operating Instructions:
 - 1. Contractor is responsible for all instructions to the Owner's representatives for the mechanical and control systems.
 - 2. If the Contractor does not have staff that can adequately provide the required instructions the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.
- 3.7 SYSTEM STARTING AND ADJUSTING
- A. The plumbing systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final adjustments as required.

- B. Complete all manufacturer-recommended startup procedures and checklists to verify proper motor rotation, electrical power voltage is within equipment limitations, equipment controls maintain pressures and temperatures within acceptable ranges, all filters and protective guards are in-place, acceptable access is provided for maintenance and servicing, and equipment operation does not pose a danger to personnel or property.
- C. Contractor shall adjust the plumbing systems and controls at season changes during the one year warranty period, as required, to provide satisfactory operation and to prove performance of all systems in all seasons.
- D. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.
- E. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.8 RECORD DOCUMENTS

- A. The following paragraphs supplement Division 1 requirements.
- B. Maintain at the job site a separate and complete set of plumbing drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.
- C. Mark drawings to indicate revisions to piping size and location, both exterior and interior; including locations devices, requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located; Change Orders; concealed control system devices.
- D. Before completion of the project, a set of reproducible plumbing drawings will be given to the Contractor for transfer of all as-built conditions from the paper set maintained at the job site. All marks on reproducibles shall be clear and permanent.
- E. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.
- F. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.
- G. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

3.9 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.
- B. Clean all areas where moisture is present. Immediately report any mold, biological growth, or water damage.
- C. Remove all rust, scale, dirt, oils, stickers and thoroughly clean exterior of all exposed piping, hangers, and accessories.
- D. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.10 SPECIAL REQUIREMENTS

- A. Contractor shall coordinate the installation of all equipment, valves, dampers, operators, etc., with other trades to maintain clear access area for servicing.
- B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

3.11 IAQ MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

- A. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:
 - 1. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:
 - a. Minimizing the amount of dust generated.
 - b. Reducing solvent fumes and VOC emissions.
 - c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.
 - d. Protect stored on-site and installed absorptive materials from moisture damage.
 - 2. Request that the Owner designate an IAQ representative.
 - 3. Review and receive approval from the Owner's IAQ representative for all IAQ-related construction activities and negative pressure containment plans.
 - 4. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.
 - 5. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.
 - 6. Request copies of and follow all of the Owner's IAQ and infection control policies.

7. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.
8. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.
9. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings Under Construction".

3.12 UTILITY REBATE

- A. Submit utility rebate forms, where offered at project location, with rebate items completed. Rebate may include lighting, lighting controls, variable speed drives, heat pumps, package terminal A/C, air conditioners, chillers, water heaters, programmable thermostats, and motors.
 1. Contractor must submit notification of any value engineering or product substitution that will affect the utility rebate amount prior to approval.

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

1. Penetrations fire sealed and labeled in accordance with specifications.
2. All pumps operating and balanced.
3. All plumbing fixtures installed and caulked.
4. Pipe insulation complete, pipes labeled and valves tagged.
5. Owner and Contractor attendance list for domestic water systems operation, maintenance, and flushing training.

Accepted by:

Prime Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION

SECTION 22 0529 - PLUMBING SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Hangers, Supports, and Associated Anchors.
- B. Equipment Bases and Supports.
- C. Sleeves and Seals.
- D. Flashing and Sealing of Equipment and Pipe Stacks.
- E. Cutting of Openings.
- F. Escutcheon Plates and Trim.

1.2 REFERENCES

- A. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- B. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
- C. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices

1.3 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

- A. Furnish sleeves and hanger inserts to General Contractor for placement into formwork.

PART 2 - PRODUCTS

2.1 HANGER RODS

- A. Hanger rods for single rod hangers shall conform to the following:

Pipe Size	Hanger Rod Diameter	
	Column #1	Column #2
2-1/2" and smaller	3/8"	3/8"
3" through 3-5/8"	3/8"	3/8"
4" and 5"	1/2"	1/2"

Column #1: Steel, cast iron, and glass pipe.

Column #2: Copper and plastic pipe.

- B. Rods for double rod hangers may be reduced one size. Minimum rod diameter is 3/8 inches.

- C. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
- D. All hanger rods, nuts, washers, clevises, etc., in damp areas shall have ASTM A123 hot-dip galvanized finish applied after fabrication. This applies to the following areas:

2.2 PIPE AND STRUCTURAL SUPPORTS

A. General:

- 1. Pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS SP-58, 69, 89, and 127 (where applicable).
- 2. On all insulated piping, provide at each support an insert of same thickness and contour as adjoining insulation, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Refer to insulation specifications for materials and additional information.
- 3. Copper piping located in an exposed area, including indirect waste piping in janitor's closets, shall use split ring standoff hangers for copper tubing. Support shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp. Use electro-galvanized or more corrosion resistant and threaded rod for floor applications. Use anchors applicable to the wall type with corrosion resistant threaded rod for wall applications.

a. Products:

- 1) Erico/M-Co Model #456
- 2) B-Line Fig. 3198HCT
- 3) Anvil Fig. CT138R
- 4) Nibco/Tolco Fig. 301CT

B. Vertical Supports:

- 1. Support and laterally brace vertical pipes at every floor level in multi-story structures, unless otherwise noted by applicable codes, but never at intervals over 15 feet. Support vertical pipes with riser clamps installed below hubs, couplings, or lugs. Provide sufficient flexibility to accommodate expansion and contraction to avoid compromising fire barrier penetrations or stressing piping at fixed takeoff locations.

a. Products:

- 1) Cooper/B-Line Fig B3373 Series
- 2) Erico 510 Series
- 3) Nibco/Tolco Fig. 82

- 2. Cold Pipe: Place restrained neoprene mounts beneath vertical pipe riser clamps to prevent sweating of cold pipes. Select neoprene mounts based on the weight of the pipe to be supported. Insulate over mounts.

a. Products:

- 1) Mason RBA, RCA or RDA
 - 2) Mason BR
3. Cold Pipe Alternative: Insulated pipe riser clamp with no thermal bridging between clamp and pipe; water repellant calcium silicate insulation material adhered inside the clamp; ASTM A653 galvanized steel clamp.
- a. Products:
- 1) Pipeshields E100
4. Wall supports shall be used where vertical height of structure exceeds minimum spacing requirements. Install wall supports at same spacing as hangers or strut supports along vertical length of pipe runs. Wall supports shall be coordinated with the Structural Engineer.
5. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.
- C. Hangers and Clamps:
1. Oversize all hangers, clamps, and supports on insulated piping to allow insulation and jacket to pass through unbroken. This applies to both hot and cold pipes.
 2. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp within their temperature limits of -65°F to +275°F.
 3. Vertical cold pipe drops and rough-ins to fixtures shall be supported by insulated pipe clamps to prevent thermal bridging and condensation.
 4. On all insulated piping, provide a semi-cylindrical metallic shield and vapor barrier jacket.
 5. Ferrous hot piping 4 inches and larger shall have steel saddles tack welded to the pipe at each support with a depth not less than specified for the insulation. Factory fabricated inserts may be used.
- a. Products:
- 1) Anvil Fig. 160, 161, 162, 163, 164, 165
 - 2) Cooper/B-Line Fig. 3160, 3161, 3162, 3163, 3164, 3165.
 - 3) Erico Model 630, 631, 632, 633, 634, 635.
 - 4) Nibco/Tolco Fig. 260-1, 261-1 1/2, 262-2, 263-2 1/2, 264-3, 265-4
6. Unless otherwise indicated, hangers shall be as follows:
- a. Clevis Type:
- 1) Service: Bare Metal Pipe, Rigid Plastic Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches & Smaller
 - 2) Products: Bare Steel Plastic or Insulated Pipe:
 - a) Anvil Fig. 260
 - b) Cooper/B-Line Fig. 3100

- c) Erico Model 400
 - d) Nibco/Tolco Fig. 1
 - 3) Products: Bare Copper Pipe:
 - a) Cooper/B-Line Fig. B3100C
 - b) Nibco/Tolco Fig. 81PVC
 - b. Continuous Channel with Clevis Type: Service: Plastic Tubing, Flexible Hose, Soft Copper Tubing:
 - 1) Products:
 - a) Cooper/B-Line Fig. B3106, with Fig. B3106V
 - b) Erico Model 104, with Model 104V
 - c) Nibco/Tolco Fig. 1V
 - c. Adjustable Swivel Ring Type:
 - 1) Service: Bare Metal Pipe - 4 inches and Smaller
 - 2) Bare Steel Pipe:
 - a) Anvil Fig. 69
 - b) Cooper/B-Line Fig. B3170NF
 - c) Erico Model FCN
 - d) Nibco/Tolco Fig. 200
 - 3) Bare Copper Pipe:
 - a) Cooper/B-Line Fig. B3170CTC
 - b) Erico 102A0 Series
 - c) Nibco/Tolco Fig. 203
7. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.
- a. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
 - b. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.
8. Unless otherwise indicated, pipe supports for use with struts shall be as follows:
- a. Clamp Type:
 - 1) Service: Bare Metal Pipe, Rigid Plastic Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches and smaller

- 2) Clamps in direct contact with copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp.
- 3) Pipes subject to expansion and contraction shall have clamps oversized to allow limited pipe movement.
- 4) Bare Steel, Plastic or Insulated Pipe:
 - a) Unistrut Fig. P1100 or P2500
 - b) Cooper/B-Line Fig. B2000 or B2400
 - c) Nibco/Tolco Fig. A-14 or 2STR
- 5) Bare Copper Pipe:
 - a) Cooper/B-Line Fig. BVT

D. Upper (Structural) Attachments:

1. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:
 - a. Steel Structure Clamps: C-Type Wide Flange Beam Clamps (for use on top and/or bottom of wide flanges. Not permitted for use with bar-joists):
 - 1) Products:
 - a) Anvil Fig. 92
 - b) Cooper/B-Line Fig. B3033/B3034
 - c) Erico Model 300
 - d) Nibco/Tolco 68
 - b. Steel Structure Clamps: Scissor Type Beam Clamps (for use with bar-joists and wide flange):
 - 1) Products:
 - a) Anvil Fig. 228, 292
 - b) Cooper/B-Line Fig. B3054
 - c) Erico Model 360
 - d) Nibco/Tolco Fig. 329
 - c. Concentrically Loaded Open Web Joist Hangers (for use with bar joists):
 - 1) Products:
 - a) MCL. M1, M2 or M3
 - d. Steel Structure Welding:

- 1) Unless otherwise noted, hangers, clips, and auxiliary support steel may be welded in lieu of bolting, clamping, or riveting to the building structural frame. Take adequate precautions during all welding operations for fire prevention and protecting walls and ceilings from smoke damage.
- e. Wood Anchors: Tension wood rod hanger for suspending 3/8" threaded rod. Zinc plated carbon steel.
 - 1) Minimum allowable tension loads for Douglass Fir/Southern Pine:
 - a) 3/8" diameter rod; 2-1/2" shank: 600 lb/590 lb.
 - b) Load values are based on full shank penetration into wood member. Minimum edge distance 3/4". Minimum end distance 3-1/4".
 - 2) Limitations:
 - a) Truss: Do not hang from wood trusses without truss manufacturer or Structural Engineer^{TMTM}s approval.
 - b) Sheetrock/Gypsum Ceiling: When drilling through non-wood materials (e.g., sheet rock, gypsum, etc.), increase shank length by depth of non-wood materials.
 - c) Plywood Flooring/Roofing: Do not hang from plywood floor or roofing.
 - d) Spacing: Refer to wood structure spacing of hangers.
 - 3) Products:
 - a) Simpson RWV
 - b) DeWALT
 - c) ITI Sammys GT25

2.3 FOUNDATIONS, BASES, AND SUPPORTS

A. Basic Requirements:

1. Furnish and install foundations, bases, and supports (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for mechanical equipment.
2. All concrete foundations, bases and supports, shall be reinforced. All steel bases and supports shall receive a prime coat of zinc chromate or red metal primer. After completion of work, give steel supports a final coat of gray enamel.

B. Concrete Bases (Housekeeping Pads):

1. Refer to Section 22 0550 for additional requirements for concrete bases in seismic applications.
2. Unless shown otherwise on the drawings, concrete bases shall be nominal 4 inches thick and shall extend 3 inches on all sides of the equipment (6 inches larger than factory base).
3. Where a base is less than 12 inches from a wall, extend the base to the wall to prevent a "dirt-trap".

4. Concrete materials and workmanship required for the Contractor's work shall be provided by the Contractor. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6"x6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at 28 days.
 5. Equipment requiring bases is as follows:
 - a. Pump
 - b. Water Heater
- C. Supports:
1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.
 2. Hang heavy equipment from concrete floors or ceilings with Architect/Engineer-approved concrete inserts, furnished and installed by the Contractor whose work requires them, except where indicated otherwise.
- D. Grout:
1. Grout shall be non-shrinking premixed (Master Builders Company "Embecco"), unless otherwise indicated on the drawings or approved by the Architect/Engineer.
 2. Use Mix No. 1 for clearances of 1" or less, and Mix No. 2 for all larger clearances.
 3. Grout under equipment bases, around pipes, at pipe sleeves, etc., and where shown on the drawings.
- 2.4 OPENINGS IN FLOORS, WALLS AND CEILINGS
- A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the General Contractor for installation or construction as the structure is built.
 - B. Coordinate all openings with other Contractors.
 - C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.
 - D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at Contractor's expense.
 - E. Do not cut structural members without written approval of the Architect or Structural Engineer.
- 2.5 ROOF PENETRATIONS
- A. Roof Curb Enclosure: Provide weatherproof roof curb and enclosure for pipe penetrations. Refer to drawings for details.

- B. Conical Pipe Boot: Seal pipes with surface temperature below 150°F penetrating single-ply roofs with conical stepped, UV-resistant silicone, EPDM or neoprene pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots or Pipetite. Color: shall match roofing membrane.
- C. Break insulation only at the clamp for pipes between 60°F and 150°F. Seal outdoor insulation edges watertight.

2.6 SLEEVES AND LINTELS

- A. Each Contractor shall provide sleeves and lintels for all duct and pipe openings required for the Contractor's work in masonry walls and floors, unless specifically shown as being by others.
- B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.
- C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Architect or Structural Engineer.
- D. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
- E. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Architect/Engineer's design.
- F. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.
- G. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
- H. Where pipes rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (e.g., foam, rubber, asphalt-coated fiber, bituminous-impregnated felt, or cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
- I. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.
- J. Wall Seals ("Link-Seals"):
 - 1. Where shown on the drawings, pipes passing through walls, ceilings, or floors shall have their annular space (sleeve or drilled hole - not tapered hole made with knockout plug) sealed by properly sized sealing elements consisting of a synthetic rubber material compounded to resist aging, ozone, sunlight, water and chemical action.
 - 2. Sleeves, if used, shall be standard weight steel with primed finish and waterstop/anchor continuously welded to sleeve. If piping carries only fluids below 120°F, sleeves may be thermoplastic with integral water seal and textured surface.
 - 3. Sleeves shall be at least 2 pipe sizes larger than the pipes.

4. Pressure shall be maintained by stainless steel bolts and other parts. Pressure plates may be of composite material for Models S and OS.
5. Sealing element shall be as follows:

Model	Service	Element Material	Temperature Range
S	Standard (Stainless)	EPDM	-40°F to 250°F
T	High/Low Temperature (Steam)	Silicone	-67°F to 400°F
T	Fire Seals (1 hour)	Silicone	-67°F to 400°F
FS	Fire Seals (3 hours)	Silicone	-67°F to 400°F
OS	Oil Resistant/Stainless	Nitrile	-40°F to 210°F

6. Manufacturers:
 - a. Thunderline Corporation "Link-Seals"
 - b. O-Z/Gedney Company
 - c. Calpico, Inc.
 - d. Innerlynx
 - e. Metraflex Company (cold service only)

2.7 ESCUTCHEON PLATES AND TRIM

- A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.
- B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.
- C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes pipe openings.

2.8 PIPE PENETRATIONS

- A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.
- B. Seal fire rated wall and floor penetrations with fire seal system as specified.

2.9 PIPE ANCHORS

- A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.
- B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

2.10 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.1 PLUMBING SUPPORTS AND ANCHORS

A. General Installation Requirements:

1. Install all items per manufacturer's instructions.
2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
4. Supports shall extend directly to building structure. Do not support piping from duct hangers unless coordinated with sheet metal contractor prior to installation. Do not allow lighting or ceiling supports to be hung from piping supports.

B. Supports Requirements:

1. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
2. Set all concrete inserts in place before pouring concrete.
3. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
4. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
5. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

C. Pipe Requirements:

1. Support all piping and equipment, including valves, strainers, traps and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
4. Piping shall not introduce strains or distortion to connected equipment.
5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:

1. Loads of 100 lbs. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.
 2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
 - a. The hanger is attached within 6" from a web/chord joint.
 - b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.
 3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
 4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.
- E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.
- F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.
- H. Steel/Concrete Structure: Spacing of hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:
1. Steel and Fiberglass (Std. Weight or Heavier - Liquid Service):
 - a. Maximum Spacing:
 - 1) 1-1/4" & under: 7'-0"
 - 2) 1-1/2": 9'-0"
 - 3) 2": 10'-0"
 - 4) 2-1/2": 11'-0"
 - 5) 3": 12'-0"
 - 6) 4" & larger: 12'-0"
 2. Steel (Std. Weight or Heavier - Vapor Service):
 - a. Maximum Spacing:
 - 1) 1-1/4" and under: 9'-0"
 - 2) 1-1/2": 12'-0"
 - 3) 2" & larger: 12'-0"
 3. Hard Drawn Copper & Brass (Liquid Service):
 - a. Maximum Spacing:

- 1) 3/4" and under: 5'-0"
- 2) 1": 6'-0"
- 3) 1-1/4": 7'-0"
- 4) 1-1/2": 8'-0"
- 5) 2": 8'-0"
- 6) 2-1/2": 9'-0"
- 7) 3": 10'-0"
- 8) 4": 12'-0"
- 9) 6": 12'-0"

4. Hard Drawn Copper & Brass (Vapor Service):

a. Maximum Spacing:

- 1) 3/4" & under: 7'-0"
- 2) 1": 8'-0"
- 3) 1-1/4": 9'-0"
- 4) 1-1/2": 10'-0"
- 5) 2": 11'-0"
- 6) 2-1/2" & larger: 12'-0"

5. Plastic Pipe:

- a. Hangers shall be spaced based on the piping system manufacturer's instructions or, if no system instructions are available, space hangers at 4'-0" maximum centers.

I. Installation of hangers shall conform to MSS SP-58, 69, 89 and the applicable Plumbing Code.

END OF SECTION

SECTION 22 0553 - PLUMBING IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Identification of products installed under Division 22.

1.2 REFERENCES

- A. ANSI/ASME A13.1 - Scheme for the Identification of Piping Systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 1. 3M
- 2. Bunting
- 3. Calpico
- 4. Craftmark
- 5. Emedco
- 6. Kolbi Industries
- 7. Seton
- 8. W.H. Brady
- 9. Marking Services

2.2 MATERIALS

- A. All pipe markers (purchased or stenciled) shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

OD of Pipe or Insulation	Marker Length	Size of Letters
Up to and including 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"

- B. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.
- C. Plastic Tags: Minimum 1-1/2" square or round laminated three-layer phenolic with engraved, 1/4" minimum black letters on light contrasting background.
- D. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all products per manufacturer's recommendations.
- B. Degrease and clean surfaces to receive adhesive for identification materials.
- C. Valves:
 - 1. All valves (except shutoff valves at equipment) shall have numbered tags.
 - 2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.
 - 3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.
 - 4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.
 - 5. Attach to handwheel or around valve stem. On lever operated valves, drill the lever to attach tags.
 - 6. Number all tags and show the service of the pipe.
 - 7. Provide one Plexiglas framed valve directory listing all valves, with respective tag numbers, uses and locations. Mount directory in location chosen by the Architect/Engineer.
- D. Pipe Markers:
 - 1. Snap-on Markers: Use Seton "Setmark" on pipes up to 5-7/8" OD. Use Seton "Setmark" with nylon or Velcro ties for pipes 6" OD and over. Similar styles by other listed manufacturers are acceptable.
 - 2. Apply markers and arrows in the following locations where clearly visible:
 - a. At each valve.
 - b. On both sides of walls that pipes penetrate.
 - c. At least every 20 feet along all pipes.
 - d. On each riser and each leg of each "T" joint.
 - e. At least once in every room and each story traversed.
- E. Equipment:
 - 1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.
 - 2. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE 90.1.

3.2 SCHEDULE

- A. Pipes to be marked shall be labeled with text as follows, regardless of which method or material is used:

1. DOMESTIC COLD WATER: White lettering; green background
2. DOMESTIC HOT WATER - 120°F: White lettering; green background
3. DOMESTIC HOT WATER - 140°F: White lettering; green background
4. DOMESTIC HOT WATER CIRCULATING - °F: White lettering; green background
5. SANITARY SEWER: Black lettering; yellow background
6. VENT: Black lettering; yellow background
7. STORM SEWER (PRIMARY AND SECONDARY): White lettering; green background

END OF SECTION

SECTION 22 0719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping Insulation.

1.2 REFERENCES

- A. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- B. ANSI/ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.
- C. ANSI/ASTM C534 - Elastomeric Foam Insulation.
- D. ASTM C1126 - Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
- E. ASTM E84 - Surface Burning Characteristics of Building Materials.
- F. NFPA 255 - Surface Burning Characteristics of Building Materials.
- G. UL 723 - Surface Burning Characteristics of Building Materials.
- H. National Commercial & Industrial Insulation Standards - 1999 Edition - as published by Midwest Insulation Contractors Association and endorsed by National Insulation Contractors Association.

PART 2 - PRODUCTS

2.1 INSULATION

- A. Type A: Glass fiber; ANSI/ASTM C547; 0.24 maximum 'K' value at 75°F; non-combustible. All-purpose polymer or polypropylene service jacket, listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.
- B. Type B: Flexible elastomeric foam insulation; closed-cell, sponge or expanded rubber (polyethylene type is not permitted); ANSI/ASTM C534 Grade 1 Type I for tubular materials; flexible plastic; 0.25 maximum 'K' value at 75°F, listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Maximum 1" thick per layer where multiple layers are specified.

- C. Type C: Molded rigid cellular glass; ANSI/ASTM C-552; 0.29 maximum 'K' value at 75°F; density 7.3lb/ft; minimum compressive strength 90 psi parallel to rise; moisture resistant, non-combustible; suitable for -100°F to +900°F. For below grade installations, use asphaltic mastic paper vapor barrier jacket. Use self-seal all-purpose polymer or polypropylene service jacket for above grade installations.

2.2 VAPOR BARRIER JACKETS

- A. All-purpose polymer or polypropylene service jacket vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 50 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.
- B. Polyvinylidene Chloride (PVDC or Saran) film and tape: Durable and highly moisture and moisture vapor resistant. Please refer to manufacturer's recommended installation guidelines.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Install insulation after piping has been tested. Pipe shall be clean, dry and free of rust before applying insulation.

3.2 INSTALLATION

A. General Installation Requirements:

- 1. Install materials per manufacturer's instructions, building codes and industry standards.
- 2. Continue insulation with vapor barrier through penetrations. This applies to all insulated piping. Maintain fire rating of all penetrations.

B. Insulated Piping Operating Below 60°F:

- 1. Insulate fittings, valves, unions, flanges, strainers, flexible connections, flexible hoses, and expansion joints. Seal all penetrations of vapor barrier.
- 2. On piping operating below 60°F in locations that are not mechanically cooled (e.g., penthouses, mechanical rooms, tunnels, chases at exterior walls, etc.), Type B insulation shall be used.
- 3. All balance valves with fluid operating below 60°F shall be insulated with a removable plug wrapped with vapor barrier tape to allow reading and adjusting of the valve.

C. Insulated Piping Operating Between 60°F and 140°F:

- 1. Do not insulate flanges and unions, but bevel and seal ends of insulation at such locations. Insulate all fittings, valves and strainers.

D. Exposed Piping:

- 1. Locate and cover seams in least visible locations.

2. Where exposed insulated piping extends above the floor, provide a sheet metal guard around the insulation extending 12" above the floor. Guard shall be 0.016" cylindrical smooth or stucco aluminum and shall fit tightly to the insulation.
3. On exposed piping serving kitchen equipment or plumbing fixtures, the piping shall be insulated unless local code allows it to be uninsulated. In no instance should the uninsulated portion of the piping be more than 4ft in developed length.

3.3 SUPPORT PROTECTION

- A. Provide a shield on all insulated piping at each support between the insulation jacket and the support.
- B. On all insulated piping greater than 1-1/2", provide shield with insulation insert of same thickness and contour as adjoining insulation at each support, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Inserts shall be as follows:
 1. The insert shall be suitable for planned temperatures, be suitable for use with specific pipe material, and shall be a minimum 180° cylindrical segment the same length as metal shields. Inserts shall be:
 - a. Cellular glass (for all temperature ranges) with a minimum compressive strength of 90 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14", provide rolled steel plate in addition to the shield.
 - b. As an alternative to separate pipe insulation insert and saddle, properly sized manufactured integral rigid insulation insert and shield assemblies may be used.
 - 1) Products:
 - a) Buckaroo CoolDry
 - b) Cooper/B-Line Fig. B3380 through B3384
 - c) Pipe Shields A1000, A2000
 - c. Insulation Couplings:
 - 1) Molded thermoplastic slip coupling, -65°F to 275°F, sizes up to 4-1/8" OD, and receive insulation thickness up to 1". Suitable for use indoors or outdoors with UV stabilizers. Vertical insulation riser clamps shall have a 1,000lb vertical load rating. On cold pipes operating below 60°F, cover joint and coupling with vapor barrier mastic to ensure continuous vapor barrier.
 - 2) Horizontal Strut Mounted Insulated Pipe Manufacturers:
 - a) Klo-Shure or equal
 - 3) Vertical:
 - a) Manufacturers: Klo-Shure Titan or equal
 - d. Rectangular blocks, plugs, or wood material are not acceptable.

- e. Temporary wood blocking may be used by the Piping Contractor for proper height; however, these must be removed and replaced with proper inserts by the Insulation Contractor. Refer to Supports and Anchors specification section for additional information.
- C. Neatly finish insulation at supports, protrusions, and interruptions.
- D. Install metal shields between all hangers or supports and the pipe insulation. Shields shall be galvanized sheet metal, half-round with flared edges. Adhere shields to insulation. On cold piping, seal the shields vapor-tight to the insulation as required to maintain the vapor barrier, or add separate vapor barrier jacket.
- E. Shields shall be at least the following lengths and gauges:

Pipe Size	Shield Size
1/2" to 3-1/2"	12" long x 18 gauge
4"	12" long x 16 gauge
5" to 6"	18" long x 16 gauge
8" to 14"	24" long x 14 gauge
16" to 24"	24" long x 12 gauge

- F. Ferrous hot piping 4 inches and larger, provide steel saddle at rollers as described in Section 22 0529 "Plumbing Supports and Anchors".
- G. Minimum 1/4" rolled galvanized steel plates shall be provided in addition to the sleeves as reinforcement on large pipes to reduce point loading on roller, trapeze hanger and strut support locations depending on insulation compressive strength. Refer to section above for exact locations.

3.4 INSULATION

- A. Type A Insulation:
 - 1. All Service Jackets: Seal all longitudinal joints with self-seal laps using a single pressure sensitive adhesive system. Do not staple.
 - 2. Insulation without self-seal lap may be used if installed with Benjamin Foster 85-20 or equivalent Chicago Mastic, 3M or Childers lap adhesive.
 - 3. Apply insulation with laps on top of pipe.
 - 4. Fittings, Valve Bodies and Flanges: For 4" and smaller pipes, insulate with 1 lb. density insulation wrapped under compression to a thickness equal to the adjacent pipe insulation. For pipes over 4", use mitered segments of pipe insulation. Finish with preformed plastic fitting covers. Secure fitting covers with pressure sensitive tape at each end. Overlap tape at least 2" on itself. For pipes operating below 60°F seal fitting covers with vapor retarder mastic in addition to tape.
- B. Type B Insulation:
 - 1. Install per manufacturer's instructions or ASTM C1710.

2. Elastomeric Cellular Foam: Where possible, slip insulation over the open end of pipe without slitting. Seal all butt ends, longitudinal seams, and fittings with adhesive. At elbows and tees, use mitered connections. Do not compress or crush insulation at cemented joints. Joints shall be sealed completely and not pucker or wrinkle. Paint the outside of outdoor insulation with two coats of latex enamel paint recommended by the manufacturer.
 3. Insulation Installation on Straight Pipes and Tubes:
 - a. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 - b. Insulation must be installed in compression to allow for expansion and contraction. Insulation shall be pushed onto the pipe, never pulled. Stretching of insulation may result in open seams and joints.
 4. Insulation Installation on Valves and Pipe Specialties:
 - a. Install preformed sections of same material as straight segments of pipe insulation when available.
 - b. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 - c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
- C. Type C Insulation:
1. Seal all longitudinal joints with manufacturer approved adhesive. Secure butt joint strips in a similar manner.
 2. Insulate fittings with prefabricated fittings.
- 3.5 JACKET COVER INSTALLATION
- A. Plastic Covering:
1. Provide vapor barrier as specified for insulation type. Cover with plastic jacket covering. Position seams to shed water.
 2. Solvent weld all joints with manufacturer recommended cement.
 3. Overlap all laps and butt joints 1-1/2" minimum. Repair any loose ends that do not seal securely. Solvent weld all fitting covers in the same manner. Final installation shall be watertight.
 4. Use plastic insulation covering on all exposed pipes including, but not limited to:
 - a. All exposed piping in mechanical and water service rooms.
- 3.6 SCHEDULE
- A. Refer to drawings for insulation schedule.

END OF SECTION

SECTION 220800 - COMMISSIONING OF PLUMBING

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. Section includes commissioning process requirements for PLUMBING systems, assemblies, and equipment.
- B. Provide documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel. Work with the Commissioning Authority and in cooperation with other members of the commissioning team to ensure compliance.
- C. Refer to Section 019113 GENERAL COMMISSIONING REQUIREMENTS for commissioning requirements.
- D. Related Sections:
 - 1. Division 01 Section "General Commissioning Requirements" for commissioning process requirements.
 - 2. Division 23 Sections related to Testing, Adjusting and Balancing (TAB).

1.3 COMMISSIONING

- A. This section governs the commissioning of Plumbing systems.
- B. The following systems and equipment shall be commissioned (*), where applicable.
 - 1. Domestic Water Heating Equipment
 - 2. Ejector Pumps
 - 3. Booster Pumps
 - 4. Elevator Pit Pumps
 - 5. Sump Pumps
 - 6. Recirculating Hot Water Systems Test and Balance

(*) The above list is not intended to be all-inclusive, but rather a representative summary of the scope of Commissioning services to be provided for HVAC&R categories.

- C. Refer to Division 01. Section 019113, "General Commissioning Requirements" for the Work related to commissioning of these systems.

PART 2 - PRODUCTS: NOT USED

PART 3 - EXECUTION: NOT USED

END OF SECTION 220800

SECTION 22 0900 - INSTRUMENTATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pressure Gauge.
- B. Thermometers.
- C. Test Plugs.

1.2 REFERENCES

- A. ANSI/AWWA C700 - Cold Water Meters - Displacement Type, Bronze Main Case.
- B. ANSI/AWWA C706 - Direct Reading, Remote Registration Systems for Cold Water Meters.
- C. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.
- D. ASME MFC-3M - Measurement of Fluid Flow in Pipes Using Orifice, Nozzle and Venturi.
- E. ASTM E1 - Specification for ASTM Thermometers.

1.3 SUBMITTALS

- A. Submit shop drawings per Section 22 0500. Include list that indicates use, operating range, total range and location for manufactured components.

PART 2 - PRODUCTS

2.1 POSITIVE DISPLACEMENT METERS (LIQUID)

- A. AWWA C700 positive displacement disc type suitable for fluid with hermetically sealed register, remote reading to AWWA C706.
- B. Provide water meters with bronze case with cast iron frost-proof, breakaway bottom cap.
- C. Meters downstream of utility company meters shall be same manufacturer as utility company meter.
- D. Meter shall contain an analog 4-20 mA output, scaled and unscaled pulse outputs for connection to the building automation system.
- E. Manufacturers:
 - 1. Neptune

2. Badger
3. Hersey.

2.2 PRESSURE GAUGES

- A. Gauges shall be 4-1/2" diameter with aluminum or stainless steel case with phosphor bronze bourdon tube, brass socket for water or oil application, 1/4" or 1/2" bottom connection. Gauges shall be 1% full scale accurate with bronze bushed brass movement and adjustable pointer. Standard ranges to be either pressure or pressure and vacuum as required of application.

1. Manufacturers:
 - a. Ashcroft
 - b. Marsh
 - c. Marshalltown
 - d. Miljoco
 - e. Trerice
 - f. U.S. Gauge Figure 1901
 - g. Weiss
 - h. Weksler
 - i. Wika.

- B. Select gauge range for normal reading near center of gauge.

2.3 PRESSURE GAUGE ACCESSORIES

- A. All pressure gauges shall have valves and pressure snubbers. All pressure gauges on steam shall have pigtail syphon.
- B. Shutoff Valve: 1/4" ball valve as specified for each piping system.
- C. Pressure snubber, brass with 1/4" connections, porous metal type.

2.4 THERMOMETERS

- A. Dial Type:
1. 4-1/2" diameter, hermetically sealed case. Stainless steel case and stem. Accuracy of 1% full scale with external recalibrator.
 2. Select thermometers for appropriate temperature range. Adjustable elbow joint with locking device to allow rotation of thermometer to any angle.
 3. Stem lengths as required for application with minimum insertion of 2-1/2" .
 4. Thermometers for water shall have brass or steel separable socket. Thermometer wells shall be stainless steel, pressure rated to match piping system design pressure; with 2-inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.
 5. Manufacturer:
 - a. Ashcroft
 - b. Marsh

- c. Marshalltown
- d. Miljoco
- e. Tel-Tru
- f. Trerice
- g. U.S. Gauge
- h. Weiss
- i. Weksler
- j. Wika.

B. Select scales to cover expected range of temperatures.

2.5 TEST PLUGS

A. Test Plug: 1/4" or 1/2" brass fitting and cap, with Nordel core for temperatures up to 275°F , for receiving 1/8" outside diameter pressure or temperature probe. Plugs shall be rated for zero leakage from vacuum to 500 psi.

B. Provide extended units for all plugs installed in insulated piping.

C. Test Kit: Carrying case, internally padded and fitted containing one 3-1/2" diameter pressure gauge with 0-100 psi range, one gauge adapter with 1/8" probes, two 1-1/2" dial thermometers with 0° to 220°F and -25°F to 125°F ranges and 5" stems.

D. Manufacturers:

- 1. Sisco
- 2. Flow Design
- 3. Peterson Equipment
- 4. MG Piping Products Co.
- 5. Miljoco
- 6. Trerice
- 7. Watts Regulator.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements:

- 1. Install per manufacturer's instructions.
- 2. Coil and conceal excess capillary on remote element instruments.
- 3. Install gauges and thermometers in locations where they are easily read from normal operating level.
- 4. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

B. Positive Displacement Meters:

1. Install positive displacement meters with shutoff valves on inlet and outlet. Provide full line size valved bypass with globe valve for liquid service meters.
- C. Pressure Gauges:
1. Connect pressure gauges to suction and discharge side of all pumps.
 2. Provide snubber for each pressure gauge.
 3. Provide coil syphon for each pressure gauge connected to steam piping.
- D. Thermometers:
1. Install piping system thermometers in sockets with short couplings. Enlarge pipes smaller than 2-1/2" for installation of thermometer sockets.
 2. Install thermometer sockets adjacent to control system thermostat, transmitter and sensor sockets.

END OF SECTION

SECTION 22 1000 - PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe and Pipe Fittings.
- B. Valves.
- C. Check Valves.

1.2 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
- B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.
- C. Welders Certification: In accordance with ANSI/ASME Sec 9 or ANSI/AWS D1.1.
- D. Piping, Fittings, Valves, and Flux for Potable Water Systems: All components shall be lead free per Federal Act S.3874, Reduction of Lead in Drinking Water Act.

1.3 REFERENCES

- A. ANSI/ASME A112.3.1 - Stainless Steel Drainage Systems for Sanitary DWV, Storm, and Vacuum Applications, Above and Below Ground.
- B. ASME A112.6.9 - Siphonic Drain Test; The American Society of Mechanical Engineers.
- C. ANSI/ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings.
- D. ANSI/ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.
- E. ANSI/ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
- F. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 NS 300.
- G. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.
- H. ANSI/ASME B16.9 - Factory-Made Wrought Steel Butt Welding Fittings.
- I. ANSI/ASME B31.3 - Chemical Plant and Petroleum Refinery Piping.
- J. ANSI/ASME Sec 9 - Welding and Brazing Qualifications.

- K. ANSI/ASTM B32 - Solder Metal.
- L. ANSI/ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
- M. ANSI/ASTM D2466 - PVC Plastic Pipe Fittings, Schedule 40.
- N. ANSI/AWS D1.1 - Structural Welding Code.
- O. ANSI/AWWA C110 - Ductile Iron and Gray Iron Fittings 3" through 48", for Water and Other Liquids.
- P. ANSI/AWWA C111 - Rubber-Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
- Q. ANSI/AWWA C153 - Compact Ductile Iron Fittings 3" through 48", for Water and Other Liquids.
- R. ASME - Boiler and Pressure Vessel Code.
- S. ASSE 1003 - Water Pressure Reducing Valves for Domestic Water Supply Systems.
- T. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- U. ASTM A74 - Hub and Spigot Cast Iron Soil Pipe and Fittings.
- V. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- W. ASTM A888 - Hubless Cast Iron Soil Pipe and Fittings.
- X. ASTM B88 - Seamless Copper Water Tube.
- Y. ASTM B306 - Copper Drainage Tube (DWV).
- Z. ASTM C14 - Concrete Sewer, Storm Drain, and Culvert Pipe.
- AA. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- BB. ASTM C1540 - Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
- CC. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
- DD. ASTM D1785 - Polyvinylchloride (PVC) Plastic Pipe, Schedules 40, 80 and 120.
- EE. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
- FF. ASTM D2661 - ABS DWV Pipe & Fittings.

- GG. ASTM D2665 - PVC DWV Pipe & Fittings.
 - HH. ASTM D2846 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems
 - II. ASTM D3033 - Type PSP (Polyvinylchloride) (PVC) Sewer Pipe and Fittings.
 - JJ. ASTM D3034 - Type PSM (Polyvinylchloride) (PVC) Sewer Pipe and Fittings.
 - KK. ASTM F402 - Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings.
 - LL. ASTM F437 - Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
 - MM. ASTM F439 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
 - NN. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipes.
 - OO. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
 - PP. ASTM F656 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
 - QQ. AWS A5.8 - Brazed Filler Metal.
 - RR. AWWA C651 - Disinfecting Water Mains.
 - SS. CISPI 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems.
 - TT. CISPI 310 - Joints for Hubless Cast Iron Sanitary Systems.
 - UU. FM 1680 - Couplings Used in Hubless Cast Iron Systems.
 - VV. NFPA 24 - Private Fire Service Mains and Their Appurtenances.
 - WW. NFPA 54 - National Fuel Gas Code.
 - XX. NFPA 58 - Storage and Handling of Liquefied Petroleum Gases.
 - YY. NSF - National Sanitation Foundation
- 1.4 DELIVERY, STORAGE, AND HANDLING
- A. Deliver and store valves in shipping containers with labeling in place.

1.5 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 22 0500 for required plumbing systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

PART 2 - PRODUCTS

2.1 CAST IRON PIPE

- A. Cast Iron; Standard Weight; Hub and Spigot Joints:
1. Pipe: Standard weight hub and spigot cast iron soil pipe, corrosion protective coating inside and outside, CISPI 301 or ASTM A888.
 2. Design Pressure: Gravity Maximum Design Temperature: 180°F
 3. Joints: Compression gasket, ASTM C564.
 4. Restraints: Install pipe and fittings per the Cast Iron Soil Pipe Institute's Designation 301. Restrain pipe and fittings using an engineered and tested product manufactured for restraining no-hub cast iron soil pipe. Install per manufacturer's recommendations.
 5. Adapters: Heavy duty no-hub transition for joining cast iron and PVC pipe. Adapters shall be tested and certified to ASTM C 1460 and be constructed with Type 304 stainless steel shield, thickness 0.015" shield, gasket material to meet ASTM C564, 1-1/2" to 4" will be 3" wide with four 304 stainless steel bands, and 6" to 10" will be 4" wide with six 304 stainless steel bands and 3/8" 305 stainless steel hex head screws torqued to 80 inch pounds.
- B. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets:
1. Pipe: Standard weight no-hub cast iron soil pipe, corrosion protective coating inside and outside, CISPI 301 or ASTM A888.
 2. Design Pressure: Gravity Maximum Design Temperature: 180°F
 3. Joints: Heavy duty, neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with at least four screw type clamps, FM 1680 or ASTM C1540.
 4. Restraints: Install pipe and fittings per the Cast Iron Soil Pipe Institute's Designation 310. Restrain pipe and fittings using an engineered and tested product manufactured for restraining no-hub cast iron soil pipe. Install per manufacturer's recommendations.
 5. Adapters: Transitions from cast iron soil pipe to other pipe materials with manufactured adapters. Heavy duty neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with not less than four screw type clamps, FM 1680 or ASTM C1540.

2.2 COPPER PIPE

- A. Copper Pipe; Type L; Solder Joints:
1. Pipe: Type L hard drawn seamless copper tube, ASTM B88.
 2. Design Pressure: 175 psi; Maximum Design Temperature: 200°F.
 3. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
 4. Fittings: Wrought copper solder joint, ANSI B16.22.

2.3 DUCTILE IRON PIPE

A. Ductile Iron Pipe; Pressure Water Pipe; Push-On Joints - Pressure Pipe:

1. Pipe: Ductile iron pressure water pipe, ANSI/AWWA C151/A21.51, 200 psi pressure class, cement-mortar lined per ANSI/AWWA C104/A21.4.
2. Design Pressure: 200 psi. Maximum Design Temperature: 150°F.
3. Fittings: Ductile iron, ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53, 200 psi pressure class, cement-mortar lined per ANSI/AWWA C104/A21.4, push-on joints.
4. Joint: Push-on joint with rubber gasket, ANSI/AWWA C111/A21.11.

2.4 PLASTIC PIPE

A. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints:

1. Pipe: Schedule 40 rigid, PVC-DWV, or ABS-DWV, normal impact Type I, with plain ends, conforming to ASTM Standards D2665 or D2661. Cellular core piping is not acceptable.
2. Joints: Solvent-weld socket type with solvent recommended by pipe manufacturer.
3. Fittings: PVC-DWV, or ABS-DWV, normal impact Type I, with solvent-weld socket type ends for Schedule 40 pipe.
4. Limits: Schedule 40 PVC-DWV, or ABS-DWV pipe must not be threaded. Do not use where exposed or in return air plenums.
5. Use: Use PVC or ABS only where allowed by local jurisdiction. Comply with all special requirements or limitations.
6. Special Requirements: Provide expansion loop(s) and/or expansion joints in the piping system per the manufacturer's guidelines and as shown on the drawings. Refer to Section 22 0516 for expansion joint requirements.

2.5 VALVES

A. Shutoff Valves:

1. For pipe systems where mechanical press connections are allowed, shutoff valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
2. Ball Valves:
 - a. BA-1: 3" and under, 150 psi saturated steam, 600 psi CWP, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and trim, Teflon seats and seals. Apollo #77C-140, Stockham #S-255-FB-P-UL, Milwaukee #BA-400, Watts, Nibco #585-70-66, National Utilities Co., RUB.
 - 1) Provide solid extended shaft for all insulated piping.

- 2) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.

2.6 STRAINERS

- A. For pipe systems where mechanical press connections are allowed, strainers with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
- B. ST-1: Bronze body, screwed ends, screwed cover, 150 psi S @ 350°F, 200 psi CWP @ 150°F. Armstrong #F4SC, Metraflex #TS, Mueller Steam Specialty Co. #351, Sarco #BT, Watts #777.

2.7 CHECK VALVES

- A. For pipe systems where mechanical press connections are allowed, check valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
- B. CK-1: 2" and under, 125# steam @ 406°F, 200# CWP @ 150°F, screwed, bronze, horizontal swing. Crane #37, Hammond #IB904, Stockham #B319-Y, Walworth #3406, Milwaukee #509, Watts #G-5000, Nibco T-413B.
- C. CK-5: 2" and under, 250# CWP, screwed, all iron, horizontal swing. Crane #346-1/2.

2.8 VALVE CONNECTIONS

- A. Provide all connections to match pipe joints. Valves shall be same size as pipe unless noted otherwise.

2.9 CONNECTIONS BETWEEN DISSIMILAR METALS

- A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.
- B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.
- C. Aluminum, iron, steel, brass, copper, bronze, galvanized steel and stainless steel are commonly used and require isolation from each other with the following exceptions:
 1. Iron and steel connected to each other.
 2. Brass, copper, and bronze connected to each other.
 3. Brass or bronze valves and specialties connected in closed systems with steel, iron, or stainless steel on both sides of the brass or bronze valves and specialties. Where two or more brass or bronze items occur together, they shall be connected with brass nipples. Brass or bronze valves and specialties cannot be used as a dielectric separation between pipe materials.

- D. Dielectric protection is required at connections to equipment of a material different than the piping.
- E. Screwed Joints (acceptable up to 2" size):
 - 1. Dielectric waterway rated for 300 psi CWP and 225°F.
 - 2. Manufacturers:
 - a. Elster Group ClearFlow fittings
 - b. Victaulic Series 647
 - c. Grinnell Series 407
 - d. Matco-Norca

PART 3 - EXECUTION

3.1 PREPARATION

- A. Install all products per manufacturer's recommendations.
- B. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- C. Remove scale and dirt, on inside and outside, before assembly.
- D. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories in preparation to be painted.
- E. Connect to equipment with flanges or unions.
- F. Use only piping materials rated for the maximum temperature of the application, e.g., do not use PVC for dishwasher drainage or piping that receives boiler blowdown.
- G. Roof Penetration (Vent) Flashing:
 - 1. Built-up Roofing: Flash vents with 3# seamless sheet lead of sufficient size to extend 15" into roofing felts for built-up roofs.
 - 2. Membrane, Metal or Shingled Roofs: Flash vents with premolded pipe flashing cones for single-ply membrane roofs, metal roofs, or shingled roofs.
- H. Existing building sewers or building drains which are shown on the documents to be reused shall be inspected and recorded by closed circuit television for their condition. Report findings back to the Architect, Engineer, and Owner before proceeding with work so any necessary rework can take place if needed.

3.2 SYSTEM, PIPING AND VALVE SCHEDULE

- A. Cold Water, Hot Water, Tempered Water (Above Ground):
 - 1. Copper Pipe; Type L; Solder Joints: All Sizes
 - 2. Shutoff Valves:, BA-1

3. Check Valves: CK-1
 4. Strainers: ST-1
- B. Combination Water and Fire Protection Service:
1. Ductile Iron Pipe; Pressure Water Pipe; Push-On Joints - Pressure Pipe: All Sizes
 2. Shutoff Valves:
- C. Sanitary Waste and Vent, Gravity (Above Ground):
1. Cast Iron; Standard Weight; Hub and Spigot Joints: All Sizes
 2. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15"
 3. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints: All Sizes
- D. Sanitary Indirect Drainage (Above Ground):
1. Cast Iron; Standard Weight; Hub and Spigot Joints: All Sizes
 2. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15"
 3. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints: All Sizes
- E. Storm Drainage, Gravity (Above Ground):
1. Cast Iron; Standard Weight; Hub and Spigot Joints: All Sizes
 2. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15"
 3. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints: All Sizes
- F. Sanitary Waste and Vent, Gravity (Underground - Inside Building):
1. Cast Iron; Standard Weight; Hub and Spigot Joints: All Sizes
 2. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15"
 3. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints: All Sizes
- G. Storm Drainage, Gravity (Underground - Inside Building):
1. Cast Iron; Standard Weight; Hub and Spigot Joints: All Sizes
 2. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15"
 3. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints: All Sizes
- H. Sanitary Waste and Vent, Gravity (Underground - Outside Building):
1. Cast Iron; Standard Weight; Hub and Spigot Joints: All Sizes
 2. Ductile Iron Pipe; Pressure Water Pipe; Push-On Joints - Pressure Pipe: 4" and larger
- I. Storm Drainage, Gravity (Underground - Outside Building):
1. Cast Iron; Standard Weight; Hub and Spigot Joints: All Sizes
 2. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15"
 3. Ductile Iron Pipe; Pressure Water Pipe; Push-On Joints - Pressure Pipe: 4" and larger

3.3 TESTING PIPING

A. Sanitary Drainage, Sanitary Vent, Storm Drainage:

1. Test all piping with water to prove tight.
2. Test piping before insulation is applied.
3. Hydrostatically test all soil, waste, and vent piping inside of building with 10 feet head of water for 15 minutes. Inspect before fixtures are connected. If leaks appear, repair them and repeat the test.
4. Hydrostatically test interior downspouts with 10 feet head of water for 15 minutes with no leaks.
5. A smoke/air test at the same pressure may be used in lieu of the hydrostatic water test. Exception: Smoke/air test shall not be performed on plastic piping.
6. Test force mains with water at 105% of the operating pump discharge pressure for 15 minutes.
7. Test pressures stated above shall be as listed or as required by the Authority Having Jurisdiction, whichever is most stringent.

B. Hot Water - Potable and Non-Potable, Cold Water - Potable and Non-Potable, Tempered Water - Potable and Non-Potable, Service Water:

1. Test pipes underground or in chases and walls before piping is concealed.
2. Test all pipes before the insulation is applied. If insulation is applied before the pipe is tested and a leak develops which ruins the insulation, replace damaged insulation.
3. Test the pipe with 100 psig water pressure or equal inert gas such as nitrogen. Exception: Inert gas test shall not be used to test plastic piping.
4. Hold test pressure for at least 2 hours.
5. Test to be witnessed by the Architect/Engineer's representative, if requested by the Architect/Engineer.

C. Fire Service:

1. Hydrostatically test the entire system for two hours at 200 psig. Maximum leakage shall be:
 - a. Interior Piping: 0 quarts per hour.
 - b. Underground Piping: 2 quarts per 100 joints per hour.

D. All Other Piping:

1. Test piping at 150% of normal operating pressure.
2. Piping shall hold this pressure for one hour with no drop in pressure.
3. Test piping using water, nitrogen, or air as compatible with the final service of the pipe. Do not use combustible fluids.
4. Drain and clean all piping after testing is complete.

3.4 CLEANING PIPING

A. Assembly:

1. Before assembling pipe systems, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Architect/Engineer's representative. Blow chips and burrs from machinery or thread cutting operation out of pipe before assembly. Wipe cutting oil from internal and external surfaces.
2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing.
3. Notify the Architect/Engineer's representative before starting any post erection cleaning in sufficient time to allow witnessing the operation. Consult with and obtain approval from the Architect/Engineer's representative regarding specific procedures and scheduling. Dispose of cleaning and flushing fluids properly.
4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, and be certain all strainer screens are in place.

B. All Water Piping:

1. Flush all piping using faucets, flush valves, etc. until the flow is clean.
2. After flushing, thoroughly clean all inlet strainers, aerators, and other such devices.
3. If necessary, remove valves to clean out all foreign material.

C. Fire Service:

1. Flush all underground piping with minimum flow equal to the system design flow but not less than the following:
 - a. 390 gpm for 4" pipes.
 - b. 880 gpm for 6" pipes.
 - c. 1560 gpm for 8" pipes.

3.5 INSTALLATION

A. General Installation Requirements:

1. Provide dielectric connections between dissimilar metals.
2. Route piping in orderly manner and maintain gradient. Install to conserve building space.
3. Group piping whenever practical at common elevations.
4. Install piping to allow for expansion and contraction without stressing pipe, joints, or equipment.
5. Slope water piping and arrange to drain at low points.
6. Install bell and spigot piping with bells upstream.
7. Where pipe supports are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
8. Seal pipes passing through exterior walls with a wall seal per Section 22 0529. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.
9. All non-potable outlets shall be clearly marked with a permanently affixed laminated sign with 3/8" high lettering saying "Non-Potable Water Not for Human Consumption." Sign shall have black lettering on a yellow background.

10. All vertical pipe drops to sinks or other equipment installed below the ceiling shall be routed within a wall cavity, unless specifically noted otherwise to be surface mounted. For renovation projects, this Contractor is responsible for opening and patching existing walls for installation of piping. Wall patching shall match existing condition.
- B. Installation Requirements in Electrical Rooms:
1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.
- C. Valves/Fittings and Accessories:
1. Install shutoff valves that permit the isolation of equipment/fixtures in each room without isolating any other room or portion of the building. Individual fixture angle stops do not meet this requirement. Exception: Back-to-back rooms in no more than two adjacent rooms.
 2. Provide clearance for installation of insulation and access to valves and fittings.
 3. Provide access doors for concealed valves and fittings.
 4. Install valve stems upright or horizontal, not inverted.
 5. Provide one plug valve wrench for every ten plug valves 2" and smaller, minimum of one. Provide each plug valve 2-1/2" and larger with a wrench with set screw.
 6. Install corrugated, stainless steel tubing system according to manufacturer's written instructions. Include striker plates to protect tubing from puncture where tubing is restrained and cannot move.
- D. Underground Piping:
1. Install buried water piping outside the building with at least 5 feet of cover. Refer to Section 22 0500 for Excavation, Fill, Backfill and Compaction requirements
 3. Install buried borosilicate glass pipe with the protective polystyrene covering intact. Lay the pipe on bedding and backfill per manufacturer instructions.
 4. Underground fire protection service piping shall have at least 6-1/2 feet of cover, or as recommended by NFPA 24.
 5. Install thrust blocking and restraints on all underground fire protection service piping per NFPA 24 and as shown on drawings.
 6. Install underground, sleeved, corrugated, stainless steel tubing system according to manufacturer's written instructions. Extend vent from sleeve to exterior of building and terminate with screened elbow.
 7. Direct buried, uninsulated steel pipe shall have a factory applied external protective coating consisting of two coats with an intermediate layer of 18 mil fibrous glass mat. Coating thickness shall total not less than 3/32". The outer coating shall be further protected by a wrapping of heavy Kraft paper. This external protection shall extend and be exposed for a minimum of 1 foot beyond the buried or concealed portion of the pipe.
 - a. Manufacturers:
 - 1) Pipe Line Service Co., Franklin Park, Illinois
 - 2) Lithcote Corp., Melrose Park, Illinois

8. As an option, the Contractor may provide factory applied protective coatings consisting of a polyethylene plastic film bonded to the pipe surface by a hot applied thermo-plastic adhesive.
 - a. Manufacturers:
 - 1) Republic Steel Corp. "X-Tru-Coat"
 9. Exercise care in handling, storing and laying pipe to avoid damaging factory applied coatings. If any damage occurs, repair the coating to a condition equal to the original.
 10. Field application of protective coatings to joints, fittings and to any damaged factory applied coatings shall be similar to factory applied coatings specified above and shall be done in strict accordance with recommendations of the supplier of pipe coatings.
 11. After completion of the fabrication, laying and field coating of the joints and fittings, but prior to backfilling, inspect the entire line in the presence of the Architect/Engineer's representative with an electronic holiday detector. Any defects in the protective coatings shall be repaired in accordance with requirements for original coatings.
 12. Coat flange bolts and nuts in pits and below ground at the time of installation with a corrosion protective coating.
- E. Sanitary and Storm Piping:
1. Install all sanitary and storm piping inside the building with a slope as shown on the drawings.
 2. Install horizontal offset at all connections to roof drains to allow for pipe expansion.
 3. Slope sanitary and storm piping outside the building to meet invert elevations shown on drawings and to maintain a minimum velocity of 2 feet per second.
 4. Sway Bracing: Where horizontal sanitary and/or storm pipes 4 inches and larger change flow direction greater than 45°, rigid bracing or thrust restraints shall be installed to resist movement of the upstream pipe in the direction of pipe flow. The rigid bracing or thrust restraint shall be connected to structure. A change of flow direction from horizontal into a vertical pipe does not require the upstream pipe to be braced.
 5. All sanitary and storm piping shall have at least 42" of cover when leaving the building.
 6. Starter fittings with internal baffles are not permitted.
- F. Siphonic Storm Piping:
1. Siphonic storm drainage is an engineered piping system. All piping components form part of the hydraulic design calculation that has been engineered to create a siphonic action and make the system function. The Contractor must refer to both the layout drawings and design calculation sheets to identify correct configuration, lengths of pipes, locations of bends, wye branches, and reducers. The Architect/Engineer shall be notified of any changes to the original design. The Contractor shall provide certified drawings from manufacturer if not the basis of design.
 2. The piping system shall comprise of swept fittings with 1/4 (90°) bend or 1/8 (45°) bends and 1/8 (45°) wye branches. 90° branches (straight or sanitary tees) are not permitted at any time. Where a right-angle branch is required, it shall be made using a 45° wye branch connecting to a 45° bend or a combination wye and 1/8 bend.
 3. Cleanout/access points are not permitted.

4. The horizontal pipe shall be installed with top of pipe (crown) level; there shall be no pitch. Any changes in diameter shall be created with the transition slope at the invert. The drawings shall notate the top of pipe level.
5. Reducers (increasers) shall be of the eccentric type and oriented to ensure the crown of the two adjoining diameters remains level and the diameter transitioning sloped pipe is at the invert.

3.6 PIPE ERECTION AND LAYING

- A. Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be removed from the job immediately.
- B. All pipe, fittings, valves, equipment and accessories shall have factory applied markings, stampings, or nameplates with sufficient data to determine their conformance with specified requirements.
- C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not install any item that is not clean.
- D. Until system is fully operational, all openings in piping and equipment shall be kept closed except when actual work is being performed on that item or system. Closures shall be plugs, caps, blind flanges or other items specifically designed and intended for this purpose.
- E. Run pipes straight and true, parallel to building lines with minimum use of offsets and couplings. Provide only offsets required to provide needed headroom or clearance and to provide needed flexibility in pipe lines.
- F. Make changes in direction of pipes only with fittings or pipe bends. Changes in size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. All fittings shall be of the long radius type, unless otherwise shown on the drawings or specified.
- G. Provide flanges or unions at all final connections to equipment, traps and valves.
- H. Arrange piping and connections so equipment served may be totally removed without disturbing piping beyond final connections and associated shutoff valves.
- I. Use full and double lengths of pipe wherever possible.
- J. Unless otherwise indicated, install all piping, including shutoff valves and strainers, to coils, pumps and other equipment at line size with reduction in size being made only at control valve or equipment.
- K. Cut all pipe to exact measurement and install without springing or forcing except in the case of expansion loops where cold springing is indicated on the drawings.
- L. Underground pipe shall be laid in dry trenches maintained free of accumulated water. Refer to Section 22 0500 for Excavation, Fill, Backfill and Compaction requirements.

- M. Unless otherwise indicated, branch take-offs shall be from top of mains or headers at either a 45° or 90° angle from the horizontal plane for air lines, and from top, bottom or side for liquids.
- N. Do not use geotextile fabric with footing tile if silt content of soil exceeds 40% or if clay content exceeds 50%. The fabric shall be installed around 1" river rock or 2" limestone.

3.7 DRAINING AND VENTING

- A. Unless otherwise indicated on the drawings, all horizontal water lines, including branches, shall pitch 1" in 40 feet to low points for complete drainage, removal of condensate and venting.
- B. Maintain accurate grade where pipes pitch or slope for venting and drainage. No pipes shall have pockets due to changes in elevation.
- C. Provide drain valves at all low points of water piping systems for complete or sectionalized draining.
- D. Use eccentric reducing fittings on horizontal runs when changing size of pipes for proper drainage and venting. Install gravity drain pipes with bottom of pipe and eccentric reducers in a continuous line; all other liquid lines with top of pipe and eccentric reducers in a continuous line.
- E. Provide air vents at high points and wherever else required to eliminate air in all water piping systems.
- F. Install air vents in accessible locations. If necessary to trap and vent air in a remote location, install an 1/8" pipe from the tapping location to an accessible location and terminate with a venting device.
- G. All vent and drain piping shall be of same materials and construction for the service involved.

3.8 PLUMBING VENTS

- A. Vent as shown on the drawings and in accordance with all codes having jurisdiction.
- B. Extend the high side of the soil and waste stacks at least 12" above roof.
- C. Flash pipes at roof with premolded EPDM pipe flashing cones adhered to roof membrane by General Contractor. Secure top of cone with stainless steel clamp and seal watertight.
- D. Increase vent pipes through the roof two pipe sizes with long increasers located at least 12" below the roof.
- E. In no case shall the vent through the roof be less than 4" in diameter.
- F. Vent pipes through the roof shall be located a minimum of 15 feet from any air intake opening on the roof.

3.9 BRANCH CONNECTIONS

- A. For domestic water and vent systems only, make branch connections with standard tee or cross fittings of the type required for the service.
- B. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.
- C. Do not use double wye or double combination wye and eighth bend DWV fittings in horizontal piping.
- D. Branch connections from the headers and mains may be mechanically formed using an extraction device. The branch piping connection shall be brazed connection for the following services only:
 - 1. Domestic water piping above ground.
- E. Further limit use of mechanically formed fittings as follows:
 - 1. Must have at least same pressure rating as the main.
 - 2. Main must be Type K or L copper tubing.
 - 3. Permanent marking shall indicate insertion depth and orientation.
 - 4. Branch pipe shall conform to the inner curve of the piping main.
 - 5. Main must be 1" or larger.
 - 6. Branch must be 3/4" or larger.
- F. Branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.
- G. Forged weld-on fittings are limited as follows:
 - 1. Must have at least same pressure rating as the main.
 - 2. Main must be 2-1/2" or larger.
 - 3. Branch line is at least two pipe sizes under main size.

3.10 JOINING OF PIPE

- A. Solder Joints (Copper Pipe):
 - 1. Make up joints with 100% lead-free solder, ASTM B32. Cut tubing so ends are perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt and grease just prior to soldering. Apply flux evenly, but sparingly, over all surfaces to be joined. Heat joints uniformly so solder will flow to all mated surfaces. Wipe excess solder, leaving a uniform fillet around cup of fitting.
 - 2. Flux shall be non-acid type.
 - 3. Solder end valves may be installed directly in the piping system if the entire valve is suitable for use with 470°F melting point solder. Remove discs and seals during soldering if they are not suitable for 470°F.
- B. Push-On Joints - Pressure Pipe (Ductile Iron, PVC Pressure):

1. Joints shall be single gasket type conforming to ANSI A21.11 "Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings". The bell shall have cast or machined gasket socket recesses, a tapered annular opening and flared socket design to provide deflections up to 5°. Plain spigot ends shall be suitably beveled for easy entry into bell, centering in gasket and compression of gasket.
 2. The joint shall be liquid tight under all pressures from vacuum to 350 psig.
 3. Furnish sufficient lubricant for a thin coat on each spigot end. Lubricant shall be non-toxic, impart no taste or odor to conveyed liquid, and have no deleterious effect on the rubber gasket. Lubricant shall be of such consistency that it can be easily applied to the pipe in hot and cold weather and shall adhere to either wet or dry pipe.
 4. Assemble per manufacturer's installation instructions.
- C. Hub and Spigot Joints - Sanitary Pipe and Storm Pipe (Cast Iron and Stainless Steel Pipe):
1. Lead and Oakum Joints: Pack joint with oakum made of vegetable fiber, cotton, or hemp. Pour joint with molten lead up to top of hub. Ensure leak-free joints by working joint with inside and outside caulking irons.
 2. Compression Gasket Joints: Joint shall be one-piece double seal compression type gasket made specifically for joining cast iron soil pipe. Gasket shall be neoprene, permitting joint to flex as much as 5 degrees without loss of seal. Gasket shall be extra heavy weight class, conforming to ASTM C-564.
- D. Solvent Weld Joints (PVC):
1. Make joints with a two-step process. Use primer conforming to ASTM F656 and solvent cement conforming to ASTM D2564.
- E. No-Hub Sleeve Gaskets (No-Hub) (Cast Iron Pipe):
1. Gasket shall be heavy weight class, conforming to ASTM C564.
 2. The gasket shall have an internal center stop.
 3. The gasket shall be covered by a stainless steel band secured with a minimum of four stainless steel bands per fitting/joint.
 4. Sleeve gaskets shall be installed in accordance with the manufacturer's installation instructions.
- 3.11 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM
- A. Disinfection of the domestic water piping shall be completed within three (3) weeks prior to building occupancy. Contractor is responsible for disinfecting water piping if used by workers during construction; disinfection during construction does not eliminate the requirement for final disinfection prior to occupancy. Flushing of piping shall be completed within two (2) weeks prior to building occupancy.
 - B. Provide necessary connections at the start of individual sections of mains for adding chlorine.
 - C. Before starting work, verify system is complete, flushed and clean.
 - D. Ensure pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

- E. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
 - F. Bleed water from all outlets to ensure chlorine distribution throughout the entire domestic water system.
 - G. Verify initial chlorination levels by testing at minimum 15% of outlets located throughout entire building, including the last fixture connected to each main and each branch extending over 50 feet from a main.
 - H. Maintain disinfectant in system for 24 hours, after which test at minimum 15% of outlets located throughout entire building, including the last fixture connected to each main and each branch extending over 50 feet from a main. If final disinfectant residual tests less than 25 mg/L at any one of the tested outlets, flush the entire system and repeat disinfection and testing procedure.
 - I. After final disinfectant residuals test at or above 25 mg/L after a minimum 24-hour duration, flush disinfectant from system at a minimum velocity of 3.0 feet/second until residual is equal to that of incoming water or 1.0 mg/L.
 - J. Take water samples, no sooner than 24 hours after flushing, from 2% of outlets and from water entry. Obtain, analyze, and test samples in accordance with AWWA C651, Section 5 - Verification.
- 3.12 SERVICE CONNECTIONS
- A. Provide new sanitary and/or storm sewer services. Before commencing work check invert elevations needed for sewer connections, confirm inverts and verify these can be properly connected with slope for drainage and cover to avoid freezing.
 - B. Provide new water service with water meter with bypass valves. Provide sleeve in wall for service main per Section 22 0529.

END OF SECTION

SECTION 22 1030 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cleanouts.
- B. Traps.
- C. Trap Seals and Primers.
- D. Floor Drains and Sinks
- E. Hub Drains and Standpipes
- F. Roof Drains.
- G. Backflow Preventers.
- H. Balancing Valves.
- I. Water Hammer Arresters.
- J. Air Vents.
- K. Drain Valves.
- L. Relief Valves.

1.2 QUALITY ASSURANCE

- A. Manufacturer: For each product specified, provide components by same manufacturer throughout.
- B. Perform work in accordance with State of California Plumbing Codes and municipality of local area standards.
- C. Piping, Fittings, Valves, and Flux for Potable Water Systems: All components shall be lead free per Federal Act S.3874, Reduction of Lead in Drinking Water Act.
- D. Valves for potable water systems shall comply with California Assembly Bill AB1953 limiting lead content. Also described in 2016 CPC: 604.2 Lead Content.

1.3 REFERENCES

- A. ANSI A112.21.1 - Floor Drains.
- B. ANSI A112.21.2 - Roof Drains.

- C. ASSE 1010 - Water Hammer Arresters.
 - D. ANSI A112.6.3 - Floor and Trench Drains; The American Society of Mechanical Engineers.
 - E. ANSI A112.6.4 - Roof, Deck, and Balcony Drains; The American Society of Mechanical Engineers.
 - F. ANSI 1012 - Backflow Preventer with Intermediate Atmospheric Vent; American Society of Sanitary Engineering.
 - G. ASSE 1013 - Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers; American Society of Sanitary Engineering; 1.
 - H. ASSE 1019 - Vacuum Breaker Wall Hydrants, Freeze Resistant Automatic Draining Type; American Society of Sanitary Engineering.
 - I. AWWA C506 - Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types.
 - J. PDI WH-201 - Water Hammer Arresters.
- 1.4 SUBMITTALS
- A. Submit shop drawings under provisions of Section 22 0500.
 - B. Include sizes, rough-in requirements, service sizes, and finishes.

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Provide cleanouts as shown and specified on the drawings as well as required by code.
- B. Coordinate floor cleanout cover with surrounding floor finish. Provide either solid, recessed for tile or terrazzo or carpet marker as applicable.
- C. Cleanouts on exposed pipes shall be cast iron with heavy duty cast brass plug with raised head.
- D. Cleanout shall be same size as the pipe up to 6" and 6" for larger pipes.

2.2 YARD CLEANOUTS

- A. Provide yard cleanouts as shown and specified on the drawings as well as required by code.
- B. Cleanout shall be same size as pipe up to 6" and 6" for larger pipes.

2.3 TRAPS

- A. Provide all individual connections to the sanitary system with P-traps, except where such drains discharge directly into a properly trapped collection basin or sump. Unless otherwise specified or shown, traps shall be:
 - 1. Chromium plated cast brass when used with plumbing fixtures or when installed exposed in finished spaces.
 - 2. Insulated at accessible lavatories.
 - 3. Cast iron, deep-seal pattern where concealed above ceiling, below grade or in unfinished areas.
 - 4. Deep-seal pattern of the same material and/or coating where drainage lines are of special materials or coatings such as polypropylene, PVDF, CPVC, etc.
- B. All traps shall have accessible, removable cleanouts, except where installed on floor drains with removable strainers.
- C. Each trap shall be completely filled with water at the end of construction but before building turnover to the Owner. All floor drains, floor sinks, trench drains, etc. shall be filled with water and a 1/2" minimum layer of mineral oil.

2.4 TRAP SEALS AND PRIMERS

- A. Provide trap seals as specified on the drawings.
- B. Provide trap primers as shown and specified on the drawings.

2.5 FLOOR DRAINS

- A. Floor drains shall be in the form of a receptor with grate/strainer set flush with the surrounding floor.
- B. Provide floor drains and sinks as shown and specified on the drawings as well as required by code.

2.6 HUB DRAINS AND STANDPIPES

- A. A hub drain shall be in the form of a hub or pipe without a grate/strainer extending through the floor for receiving indirect waste. A hub drain has a flood level rim above the finished floor.
- B. Provide hub drains as shown and specified on the drawings as well as required by code.

2.7 ROOF DRAINS

- A. Provide roof drains as shown and specified on the drawings as well as required by code.

2.8 BACKFLOW PREVENTERS

- A. Provide backflow preventers as shown and specified on the drawings as well as required by code.

2.9 STRAINERS

- A. Unless otherwise indicated, strainers shall be Y-pattern and have stainless steel screens with perforations as follows:
 - 1. Water:
 - a. 1/4" - 2": 3/64" perforations
 - b. 2-1/2" - 10": 1/16" perforations
 - c. 12" - 18": 1/8" perforations
- B. Furnish pipe nipple with shutoff valve to blow down all strainer screens.
- C. Use bronze body strainers in copper piping and iron body strainers in ferrous piping.

2.10 UNIONS

- A. Copper pipe - wrought copper fitting - ground joint.

2.11 BALANCING VALVE

- A. Rated for 125 psi working pressure and 250°F operating temperature, taps for determining flow with a portable meter, positive shutoff valves for each meter connection, memory feature, tight shutoff, and a permanent pressure drop between 1' and 2' water column at full flow with valve 100% open. Furnish with molded, removable insulation covers.
- B. Provide a nomograph to determine flow from meter reading (and valve position on units which sense pressure across a valve). Graph shall extend below the specified minimum flow.
- C. Furnish one meter kit equivalent to Bell & Gossett Model RO-5 meeting the following requirements:
 - 1. Carrying case with handle.
 - 2. Pressure gauge with 0-25 feet of head scale with 3.0% full scale accuracy.
 - 3. High and low side hoses with 5 feet length and 250 psig pressure rating, equipped with shutoff valves, vent valves, and probes for insertion into pressure and temperature plugs.
 - 4. Coordinate with the Mechanical Contractor if a meter kit is also required in Section 23 2100. It is not our intent to require two identical kits, rather it will be acceptable to provide only one kit to the owner which can be used with both plumbing and hydronic piping systems.
- D. Flow rate of 0.5 GPM or larger: Valves in copper piping shall be brass or bronze. Acceptable Manufacturers: Flow Design "Accusetter", Preso "B+", Armstrong "CVB", Bell & Gossett "Circuit Setter Plus", Griswold "Quickset", Gerand "Balvalve Venturi" or Nibco Globe Style balancing valve.
- E. Flow rate less than 0.5 GPM: Valves in copper piping shall be brass or bronze. Cv value shall be less than 1.0 when valve is completely open, and minimum balanceable flow rate shall not exceed 0.1 GPM with a meter reading of at least 2.5 feet. Acceptable manufacturers: Bell & Gossett "Circuit Setter RF", Flow Design, Preso, Armstrong, Griswold, Gerand, or Nibco balancing valve.

- F. Manufacturer shall size balancing valves for the scheduled flow rate. Flow rate shall be measurable on manufacturer's standard meters.

2.12 WATER HAMMER ARRESTERS

- A. Provide water hammer arresters as shown and specified on the drawings as well as required by code.
- B. ANSI A112.26.1; sized and located in accordance with PDI WH-201, precharged for operation between -100°F and 300°F and maximum 250 psig working pressure.

2.13 DIELECTRIC FITTINGS (CONNECTIONS BETWEEN DISSIMILAR METALS)

- A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.
- B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.
- C. Aluminum, iron, steel, brass, copper, bronze, and stainless steel are commonly used and require isolation from each other with the following exceptions:

1. Iron, steel, and stainless steel connected to each other.
2. Brass, copper, and bronze connected to each other.
3. Brass or bronze valves and specialties connected in closed systems with steel, iron, or stainless steel on both sides of the brass or bronze valves and specialties. Where two or more brass or bronze items occur together, they shall be connected with brass nipples. Brass or bronze valves and specialties cannot be used as a dielectric separation between pipe materials.

- D. Dielectric protection is required at connections to equipment of a material different than the piping.

- E. Screwed Joints (acceptable up to 2" size):

1. Dielectric waterway rated for 300 psi CWP and 225°F.
2. Acceptable Manufacturers: Elster Group ClearFlow fittings, Victaulic Series 47, Grinnell Series 407, Matco-Norca.

- F. Flanged Joints (any size):

1. Use 1/8" minimum thickness, non-conductive, full-face gaskets.
2. Employ one-piece molded sleeve-washer combinations to break the electrical path through the bolts.
3. Sleeve-washers are required on one side only, with sleeves minimum 1/32" thick and washers minimum 1/8" thick.
4. Install steel washers on both sides of flanges to prevent damage to the sleeve-washer.

5. Separate sleeves and washers may be used only if the sleeves are manufactured to exact lengths and installed carefully so the sleeves must extend partially past each steel washer when tightened.
6. Acceptable Manufacturers: EPCO, Central Plastics, Pipeline Seal and Insulator, F. H. Maloney, or Calpico.

2.14 AIR VENTS

- A. Provide means for venting air at all high points in the piping system and at all other points where air may be trapped.
- B. At end of main and other points where large volume of air may be trapped - Use 1/4" globe valve, angle type, 125 psi, Crane #89, attached to coupling in top of main, 1/4" discharge pipe turned down with cap.

2.15 DRAIN VALVES

- A. Drain valves shall be shutoff valves as specified for the intended service with added 3/4" male hose thread outlet and cap.

2.16 RELIEF VALVES

- A. RV-4: (Domestic Hot Water) Pressure and Temperature relief, cast bronze body and internal parts, stainless steel spring, test lever, threaded inlet and outlet. Maximum setting of 150 psi and 210°F temperature. Capacities ASME certified and labeled. Acceptable Manufacturers: Cash Series FV, Watts #40, #120, #N240, #340.

PART 3 - EXECUTION

3.1 INSTALLATION AND APPLICATION

- A. Coordinate construction to receive drains at required invert elevations.
- B. Install all items per manufacturer's instructions.
- C. Water Hammer Arresters:
 1. Install water hammer arresters in accessible locations. Provide access doors as required. Coordinate type with Architect/Engineer/Owner.
 2. Water hammer arrestors shall be installed in cold and hot water lines upstream of all plumbing fixtures or equipment, with a quick acting valve or multiple quick acting valves. Quick acting valves shall be defined as solenoid actuated valves, manual flush valves, sensor activated faucets and flush valves, squeeze handle spray faucets, and other similar type valves.
 3. Install multiple water hammer arrestors in toilet group branch piping greater than 20 feet in developed length from the cold and hot water mains.
- D. Cleanouts:

1. Provide cleanouts where shown on the drawings and as required by code, but in no case farther apart than 50 feet in pipe less than 6" size and 100 feet apart in 6" and larger pipes inside the building. Provide cleanouts at bases of all sanitary and storm risers as shown on the drawings and as required by code.
 3. Extend cleanouts to the floor with long sweep elbows.
 4. Install a full size, two-way cleanout within 5 feet of the foundation inside or outside of building.
 5. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with graphite and linseed oil. Ensure clearance at cleanouts for rodding of drainage system.
 6. Wall cleanouts shall be installed above the flow line of the pipe they serve, but no less than 12" above the finished floor.
- E. Yard Cleanouts:
1. Install cleanouts on maximum 90 foot centers (including riser) for pipes 8" and smaller.
 2. Extend cleanout to grade. Encase cleanout in 5" thick concrete pad extending 6" beyond cleanout, set low enough not to interfere with lawn mowers.
- F. Trap Seals and Primers:
1. Install trap guard on all drains
- G. Floor Drains and Floor Sinks:
1. Drains in upper floors shall have a flashing of EPDM or similar membrane sheet. The sheet shall be at least 36" X 36" square with the drain in the center. Clamp membrane in auxiliary clamping ring of floor drain. Membrane is not required if upper floor construction is single pour, cast-in-place concrete.
 2. Use alternate sealing method when installing drains in existing floor slabs.
 3. Coordinate sloping requirements with the architectural plans and specifications.
 4. Top of floor drain and sinks grate/strainer shall not extend above the finished floor elevation.
 5. Top of floor drain and sink grate/strainer shall not extend above the finished floor elevation. Grate/strainer shall be installed flush with surrounding finished floor. Should the Plumbing Contractor believe this presents a conflict with code, the issue should be evaluated before installation of the floor drain or sink begins. Proceeding with installing a floor drain or sink raised above the finished floor without prior approval will result in the Contractor being required to remove the drain or sink in question and reinstall it at the approved elevation.
- H. Hub Drains and Standpipes:
1. The top of a hub drain/standpipe shall extend above the finished floor elevation. Refer to drawings for dimensions above the finished floor.
 2. Access shall be provided to drains and standpipes for rodding.
- I. Roof Drains:
1. Roof drains shall have bearing pans.
 2. Provide auxiliary support steel under drains as required to prevent movement of the drain.
 3. All roof drains shall have underdeck clamps.

4. Drains in built-up roofing systems shall have a 36" x 36", 3 lb density lead sheet flashing.

J. Backflow Preventer:

1. Provide an air gap fitting and piping to drain. On 2-1/2" and larger units, install a tail piece from air gap fitting to drain to prevent water from spraying out of drain air gap receptor. Maintain air gap distance required by Code.
2. Units shall be field tested and tagged in accordance with manufacturer's instructions and applicable codes by a certified tester before initial operation.
3. Install unit between 12" and 60" above finish floor.

K. Balancing Valves:

1. Install balancing valves with straight, unobstructed pipe section both upstream and downstream as required, per manufacturer's installation instructions.

END OF SECTION

SECTION 22 1123 - DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Domestic Water In-Line Circulators.

1.2 SUBMITTALS

- A. Submit shop drawings under provisions of Section 22 0500.
- B. Submit certified pump performance curves with pump and system operating point plotted. Include NPSH curve when applicable.
- C. Pumps with motors operating above the RPM the pump curves are based on shall have impellers trimmed to deliver GPM and head scheduled.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Statically and dynamically balance rotating parts.
- B. Construction shall permit complete servicing without breaking piping or motor connections.
- C. Pumps shall operate at 1750 rpm unless specified otherwise.
- D. Pump connections shall be flanged, whenever available.
- E. Domestic hot water pumps shall be suitable for 225°F water.
- F. Motors shall comply with Section 22 0513.
- G. Submitted pump selections must have a diameter impeller that meets or exceeds the scheduled pump. The inlet and discharge pipe sizes shall also meet or exceed the scheduled pump.

2.2 DOMESTIC WATER IN-LINE CIRCULATORS

- A. Provide pumps as specified on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General Installation Requirements:

1. Install all products per manufacturer's recommendations.
 2. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- B. In-Line Pump:
1. Support in-line pumps individually so there is no strain on the piping. Support pump so no weight is carried on pump casings. Install with a minimum of five diameters of straight pipe on pump suction and discharge.
 2. Ensure pumps operate at specified fluid temperatures without vapor binding or cavitation, are non-overloading in parallel or individual operation, and operate within 25% of midpoint of published maximum efficiency curve.
 3. Pumps shall be factory aligned. If alignment is not satisfactory, as determined by the Architect/Engineer, manufacturer shall provide a factory trained representative to field align the shafts.
- C. Pump without VFD:
1. For pumps not powered by a VFD, trim impeller to meet maximum operating conditions. Coordinate final trimmed diameter with Testing, Adjusting, and Balancing Contractor and Architect/Engineer.

END OF SECTION

SECTION 22 3000 - PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Water Heaters.
- B. Pressure Booster System.

1.2 QUALITY ASSURANCE

- A. Products and installation of specified products shall conform to recommendations and requirements of the following organizations:
 - 1. American Gas Association (AGA).
 - 2. National Sanitation Foundation (NSF).
 - 3. American Society of Mechanical Engineers (ASME).
 - 4. National Board of Boiler and Pressure Vessel Inspectors (NBBPVI).
 - 5. National Electrical Manufacturers' Association (NEMA).
 - 6. Underwriters' Laboratories (UL).
- B. Water Heater Performance Requirements: Equipment efficiency not less than prescribed by ASHRAE 90.1 when tested in accordance with DOE 10 CFR, ANSI Z21.10.1 and ANSI Z21.10.3.
- C. Conform to ASME Section VIII for construction of water heaters and heat exchangers. Provide boilers registered with National Board of Boiler and Pressure Vessel Inspectors.

1.3 REFERENCES

- A. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- B. ANSI/ASME Section 8D - Pressure Vessels.
- C. ANSI/NFPA 30 - Flammable and Combustible Liquids Code.
- D. ANSI/NFPA 54 - National Fuel Gas Code.
- E. ANSI/NFPA 70 - National Electrical Code.
- F. ASSE 1005 - Water Heater Drain Valves, 3/4" Iron Pipe Size.

1.4 SUBMITTALS

- A. Submit shop drawings under provisions of Section 22 0500.

- B. Include dimension drawings of water heaters indicating components and connections to other equipment and piping.
- C. Include heat exchanger dimensions, size of tappings, and performance data.
- D. Include dimensions of tanks, tank lining methods, anchors, attachments, lifting points, tappings, and drains.
- E. For equipment connected to an electric power source, submit short circuit rating (SCCR) of integrated unit.
- F. Submit manufacturer's installation instructions including control and electrical power/controls wiring diagrams.
- G. Submit manufacturer's certificate that pressure vessels meet or exceed specified requirements.
- H. Submit operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.6 REGULATORY REQUIREMENTS

- A. Conform to ANSI/ASME Section 8 Division 1 for fabrication of steel pressure vessels.
- B. Conform to ANSI/ASME Section 10 for manufacture of fiber-reinforced plastic pressure vessels.

PART 2 - PRODUCTS

2.1 WATER HEATERS

- A. All water heaters shall be as scheduled on the drawings.

2.2 PRESSURE BOOSTER SYSTEMS

- A. Packaged pressure boosting system shall be completely factory assembled, run-tested, and shipped to site as an integral unit assembled on a steel skid including pumps, motors, valves, stainless steel suction and discharge manifolds, all interconnecting piping, wiring, variable frequency drives with Logic and power controls. Size and capacity shall be as scheduled on the drawings.
- B. Shutoff valves shall be provided on the suction and discharge of each pump. Silent spring- loaded check valves shall be installed on the discharge of each pump.

- C. Pressure gauges shall be provided on the front cover of the control panel indicating system suction and discharge pressure. Pressure gauges shall be 4-1/2 inch diameter, Grade 1A, having 1% total range span accuracy and installed with shutoff valve and pressure snubber at gauge connection to system piping. All skid-mounted components shall be factory finished with enamel paint. Individual pumps, motors, variable frequency drives, and check valves shall be serviceable with the booster system in operation, and all components shall be suitable for the maximum system working pressure.
- D. System shall include two mounted pumps with ANSI flanged or NPT threaded connections, replaceable casing wear rings, and hydraulically balanced impellers. Pumps shall be cast iron, bronze or stainless steel fitted construction with replaceable shaft sleeves and mechanical seals suitable for 175 psig working pressure.
- E. Pressure regulating valves to control system pressure at the unit are not allowed per ASHRAE 90.1.
- F. Each pump shall include a pressure relief valve, set to relieve 15 psi above the high limit pressure switch setting, which shall be piped to a floor drain by the installing contractor.
- G. Provide a hydro-pneumatic tank with carbon steel or fiberglass shell and a replaceable FDA-approved, heavy-duty bladder to separate the air and water. No water shall come in contact with metal tank walls. Features shall include an air fill valve and bottom system connection suitable for 100% draw-down. Tank shall be constructed in accordance with Section VIII of the ASME code and be N.B. stamped. Refer to schedule on drawings for size. .
- H. Provide each pump with a premium efficient open drip-proof motor labeled for use with variable frequency drives (VFDs) and sized for operation at any point of the pump curve, including pump run-out (non-overloading operation).
- I. Provide and mount on the system skid two VFDs suitable for variable torque applications. Minimum acceptable VFD full load/full speed efficiency shall be 97%, with a fundamental power factor of 0.98. VFDs shall meet the following:
 - 1. Pulse width modulated (PWM).
 - 2. Starts into rotating load.
 - 3. Overcurrent protection.
 - 4. Adjustable carrier switching frequency of up to 8 kHz.
 - 5. Keypad operator device or touchscreen that includes the following:
 - a. 2-line backlit display.
 - b. Power on and alarm/fault indicators
 - c. Hand-Off-Auto switch on VFD front panel cover
 - d. When switched to "Auto" operation, the VFDs shall follow the signal from the control panel logic section.
 - e. When switched to "Hand", the VFD speed is determined by the setting of the manual speed adjustment located on the VFD front panel cover.
 - f. Automatic VFD shutdown for electrical fault
 - g. Automatic restart after electrical power is restored from a loss of power
 - h. Service diagnostics with fault history log.

- J. Provide a high limit pressure switch compatible with the system controls, temperature, and pressure requirements. The pressure switch shall be mounted and wired on the control panel, with sensing line connected to the system discharge manifold. The high limit pressure switch shall shut down the system if the system pressure is more than 30 psi above the normal operating pressure.
- K. Provide a pressure sensor/transmitter, shipped loose for field installation, that provides a modulating output compatible with the system controls. The pressure sensor/transmitter shall be used to control booster pump VFDs to maintain a constant system pressure.
- L. Provide a factory-mounted pressure sensor/transmitter in the discharge header that provides a modulating output compatible with the system controls. The pressure sensor/transmitter shall be used to control booster pump VFDs to maintain a constant system pressure. Control logic shall be capable of adjusting the pressure setpoint using a system pressure drop algorithm based on real-time flow data.
- M. Use of a single pressure sensor/transmitter to control system pressure and high limit pressure cutoff is not acceptable. Both the high limit pressure switch and the pressure sensor/transmitter shall be separately wired back to the booster pump control panel.
- N. The lead pump shall run only as necessary to maintain system pressure and will be automatically controlled by means of a pressure sensor/transmitter and control programming to prevent short cycling.
- O. If the lead pump is unable to maintain system pressure at the pressure sensor/transmitter, the lag pump will be called on after a time delay and will operate in parallel with the lead pump in accordance with control programming. When a low or no-flow condition is reached, the controls will shut down the lag pump if running and accelerate the lead pump to charge the system and hydro-pneumatic tank to 20 psi above normal operating pressure, then shut the lead pump down and alternate. Should any pump fail to operate, the next pump in sequence shall start automatically.
- P. Provide, mount and wire on the skid a programmable logic controller in a NEMA 1 enclosure. The controller shall interface the signals from the sensors to the VFDs and shall provide a stabilized response to speed up or slow down the pump or add additional pumps to meet system requirements. The controller shall provide setpoint control that can be changed by a keypad entry on the control faceplate. The controller shall have an alpha/numeric display, PID functions and both system and controller self-diagnostics. Controller shall be provided with dual function PID loop for startup mode and normal operation. Startup mode shall provide a quick response from shutdown and normal operation is tuned to eliminate hunting. Controller shall have a real-time calendar/clock and memory transfer cartridge.
- Q. Provide a UL listed control panel in a NEMA 1 enclosure, factory mounted and wired on the steel skid. The panel shall be furnished with individual pump disconnects with through-the-door handles, pump run lights, H-O-A selector switches, 120-volt fused control transformer, and necessary relays, timers and a programmable controller with pump start, stop and sequence controls.
- R. The controller shall be capable of outputting system pressure and a general alarm signal to the building automation system.

- S. Non-mercury low pressure control to stop pump operation if incoming water pressure drops to atmospheric.
- T. Size and capacity shall be as scheduled on the drawings.
- U. Manufacturers:
 - 1. Xylem B&G
 - 2. Grundfos
 - 3. Goulds
 - 4. Metropolitan
 - 5. HYFAB
 - 6. QuantumFlo
 - 7. or approved equivalent

PART 3 - EXECUTION

3.1 INSTALLATION

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

3.2 WATER HEATER INSTALLATION

- A. Install water heaters on concrete bases. Coordinate sizes and locations of concrete bases. Refer to Section 22 0529.
- B. Install water heaters level and plumb, according to drawings, manufacturer's instructions, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- C. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend drain piping full size from relief valve and discharge by positive air gap onto closest floor drain. Discharge pipe material shall be same as domestic water piping.

3.3 PRESSURE BOOSTER INSTALLATION

- A. Provide startup by factory authorized start-up technician.
- B. Mount pressure sensor/transmitter used to control pressure booster pump VFDs remote from booster pump skid near the most remote critical plumbing fixture as indicated on the drawings, and wire signal directly back to pressure booster control panel. Pressure sensor/transmitter signal shall not interface with or be transmitted across any building information system network. Provide signal amplifiers or repeaters as required to ensure proper control operation.
- C. Provide four (4) hours of instruction and orientation to the Owner's maintenance staff by factory trained personnel. System walk-through, including programming of any system controllers, shall be included in the training.

- D. Support piping adjacent to pumps so that no weight is carried by pump casings. Provide supports under elbows on 4" and larger.
- E. Ensure pumps operate at specified fluid temperatures without vapor binding or cavitation, are non-overloading in parallel or individual operation, and operate within 25% of midpoint of published maximum efficiency curve.
- F. Pumps shall be factory aligned. If alignment is not satisfactory, as determined by the Architect/Engineer, manufacturer shall provide a factory trained representative to field align the shafts.
- G. Unless otherwise shown on the drawings, mount all pump skids on 4" high concrete pads and anchor frames to pads with cast-in-place anchors.
- H. All pump skids shall be grouted in. Follow manufacturer's instructions for grouting.
- I. Install on vibration isolators as scheduled on drawings.
- J. Coordinate installation to ensure manufacturer's recommended service clearances are met.

END OF SECTION

SECTION 22 4000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. All plumbing fixtures.

1.2 REFERENCES

- A. ANSI A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use.
- B. ANSI A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.
- C. ANSI A112.19.1M - Enameled Cast Iron Plumbing Fixtures.
- D. ANSI A112.19.2M - Vitreous China Plumbing Fixtures.
- E. ANSI A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
- F. ANSI A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.
- G. AHRI 1010 - Drinking Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers.
- H. Americans with Disabilities Act (ADA), Title III.
- I. The Energy Policy Act (EPAct) of 2005.

1.3 SUBMITTALS

- A. Submit product data under provisions of Section 22 0500. Submittals shall include fixture carriers for record purposes only. Architect/Engineer does not review or approve carriers except for manufacturer.
- B. Include fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
- C. For fixtures and trim requiring electrical connections, submit product data indicating general assembly, components, electrical power/controls wiring diagrams, and service connections.

PART 2 - PRODUCTS

2.1 DSA FIXTURE REQUIREMENT

- A. Plumbing fixtures and accessories provided in a toilet room or bathing room are required to comply with CBC Section 11B-213.2 and shall comply with CBC Section 11B-213.3.

- B. Effective March 1, 2017, all single-user toilet facilities shall be identified as Gender-Neutral facilities by a door symbol that complies with CBC Sections 11B-216.8 and 11B-703.2.6.3. No pictogram, text, or braille is required on the symbol. If tactile jamb signage is provided, the signage shall comply with the appropriate technical requirements of CBC Section 11B-703. Examples of appropriate designations are "ALL-GENDER RESTROOM", "RESTROOM" or "UNISEX RESTROOM". DSA BU 17-01.
- C. Accessible plumbing fixtures shall comply with all the requirements in CBC Division 6.
- D. Clearance around accessible water closets and in toilet compartments shall be 60 inches minimum measured perpendicular from the side wall and 56 inches minimum measured perpendicular from the rear wall per CBC Section 11B-604.4.1.
- E. Heights and location of all accessible fixtures shall be mounted according to CBC Sections 11B-602 through 11B-612.
- F. Fixture controls shall comply with CBC Sections 11B-601.3 for drinking fountains, 11B-604.6 for water closets, 11B-604.9.5 for children's water closets, 11B-605.4 for urinals, 11B-606.4 for lavatories and sinks, 11B-607.5 for bathtubs, 11B-608.5 for showers, and 11B-611.3 for washing machines and clothes dryers.
- G. Accessible sinks shall be 6-1/2" deep maximum. Sinks shall be mounted with the front of the higher of the rim and counter surface 34" maximum above the finish floor or ground.
- H. Water supply and drain pipes under lavatories and sinks shall be insulated or otherwise configured to protect against contact. There shall be no sharp or abrasive surfaces under lavatories and sinks. CBC Section 11B-606.

2.2 MATERIALS

- A. Wall Hung Fixture Carriers:
 - 1. Material: All Metal, ASME/ANSI A112.6.1M.
 - 2. Manufacturers:
 - a. Zurn
 - b. Smith
 - c. Wade
 - d. Josam
 - e. Watts
 - f. Mifab.
- 3. Water closet carrier shall be rated to support 500 lbs. unless noted otherwise on the drawings.
 - B. All fixtures shall be as scheduled on the drawings.
 - C. All china shall be from the same manufacturer where possible.
 - D. All lavatory and sink trim shall be from the same manufacturer where possible.

- E. All fixtures shall be lead free. Faucets, traps, stops, and other fixture accessories shall not contain more lead than allowed per the latest State or Federal Act.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements:

1. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.
 2. Install each fixture with trap easily removable for servicing and cleaning. Use screwed tailpiece couplings. Connect fixture waste to stack with slip fitting.
 3. Provide fixtures with chrome plated rigid or flexible supplies, loose key stops, reducers, and escutcheons.
 4. Install components level and plumb.
 5. Caulk joint between finish floor and floor mounted fixtures and between finish walls and wall mounted fixtures with silicon caulk. Caulk the joint, between rim and fixture where a fixture builds into a counter top, with caulking compound. Refer to DIVISION 7 for "Caulking" requirements. Color to match fixture.
 6. Where there is a possibility of water following pipe brackets, etc., into a wall; caulk escutcheons, space around brackets, etc., to exclude water. Refer to DIVISION 7 for "Caulking" requirements.
7. Refer to architectural drawings for fixture mounting heights.

B. Wall-Mounted Fixture Requirements:

1. All wall-mounted fixtures shall have compatible carriers designed for their intended service and suitable for the space available and configuration of fixtures. All carriers shall extend to the floor and be anchored to the slab.

C. Exposed or Inside Accessible Cabinets Traps, Valve and Pipe Requirements:

1. All traps exposed under fixtures or inside accessible cabinets shall be chrome plated brass.
2. All water or waste piping for plumbing fixtures that is exposed or inside cabinets shall be chrome plated.
3. All exposed flush valves for water closets and urinals shall have a chrome plated hanger to anchor the piping to the wall.
4. All exposed water supply piping and fittings in a finished space to a shower valve, hose bibb, or other water outlet shall be chrome plated.

D. ADA Accessible Exposed Sink and Lavatory Trim:

1. All exposed sink and lavatory traps, piping and angle stops installed at accessible sink and lavatory locations shall include offset style drain tailpiece, p-trap installed near and parallel with back wall, and insulation kit specially manufactured for this installation. Armaflex with duct tape is not acceptable.

E. ADA Accessible Water Closet Requirements:

1. Handicapped accessible water closet flush valve handles shall face the center of the stall.
2. Coordinate flush valves in handicap accessible locations with grab bars installed by the General Contractor. Make modifications as necessary to flush valve piping to avoid conflict with grab bars. Common solutions include shortened or offset vacuum breaker tailpieces.

F. Bathtubs and Shower Requirements:

1. All acrylic and fiberglass bathtubs and showers shall have a non-shrink grout or manufacturer-approved material installed between the finished floor and floor of the fixture to prevent damage caused by deflection.
2. All rough-in pockets for showers and tubs located in basement floor installations shall be filled in with concrete and sealed tight.

3.2 ADJUSTING AND CLEANING

- A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.
- B. At completion, clean plumbing fixtures, equipment, and faucet aerator screens.

3.3 FIXTURE ROUGH-IN SCHEDULE

- A. Rough-in fixture piping connections in accordance with table on plumbing drawings of minimum sizes for particular fixtures.

END OF SECTION

SECTION 23 0500 - BASIC HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 23 Sections. Also refer to Division 01 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
 - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
 - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" (40 mm) and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" (40 mm) and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - d. Maintenance clearances and code-required dedicated space shall be included.
 - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
 - a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.

3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
 - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
 - a. Scale of drawings:
 - 1) General plans: 1/4 Inch = 1'-0" (minimum).
 - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
 - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
 - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
 - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
 - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
 - b. Potential layout changes shall be made to avoid additional access panels.
 - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
 - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
 - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.3 QUALITY ASSURANCE

- A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
 2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.
- B. Qualifications:
1. Only products of reputable manufacturers are acceptable.
 2. All Contractors and subcontractors shall employ only workers skilled in their trades.
- C. Compliance with Codes, Laws, Ordinances:
1. Conform to all requirements of the City of Evanston Codes, Laws, Ordinances and other regulations having jurisdiction.
 2. Conform to all State Codes.
 3. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
 4. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
 5. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
 6. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
 7. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.
- D. Permits, Fees, Taxes, Inspections:
1. Procure all applicable permits and licenses.
 2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
 3. Pay all charges for permits or licenses.
 4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
 5. Pay all charges arising out of required inspections by an authorized body.

6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
- E. Utility Company Requirements:
1. Secure from the appropriate private or public utility company all applicable requirements.
 2. Comply with all utility company requirements.
 3. Make application for and pay for service connections, such as gas.
 4. Make application for and pay for all meters and metering systems required by the utility company.
- F. Examination of Drawings:
1. The drawings for the mechanical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
 2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
 3. Scaling of the drawings is not sufficient or accurate for determining these locations.
 4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
 5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
 6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
 7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
 8. Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
 - a. Any item listed as furnished shall also be installed, unless otherwise noted.
 - b. Any item listed as installed shall also be furnished, unless otherwise noted.
- G. Field Measurements:
1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.
- H. Electronic Media/Files:
1. Construction drawings for this project have been prepared utilizing Revit.
 2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
 3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.

4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

1.4 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals List:

Referenced Specification Section	Submittal Item
23 05 93	Testing, Adjusting, and Balancing
23 09 00	Controls
23 34 23	Power Ventilators
23 36 00	Terminal Air Boxes
23 37 00	Grilles, Registers, and Diffusers
23 74 16.12	Packaged Rooftop Air Conditioning Units - 25T and Below
23 81 26	Split System Air Conditioning Units
23 82 00	Terminal Heat Transfer Equipment

- B. General Submittal Procedures: In addition to the provisions of Division 01, the following are required:

1. Transmittal: Each transmittal shall include the following:
 - a. Date
 - b. Project title and number
 - c. Contractor's name and address
 - d. Division of work (e.g., plumbing, heating, ventilating, etc.)
 - e. Description of items submitted and relevant specification number
 - f. Notations of deviations from the contract documents
 - g. Other pertinent data
2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:

- a. Date
 - b. Project title and number
 - c. Architect/Engineer
 - d. Contractor and subcontractors' names and addresses
 - e. Supplier and manufacturer's names and addresses
 - f. Division of work (e.g., plumbing, heating, ventilating, etc.)
 - g. Description of item submitted (using project nomenclature) and relevant specification number
 - h. Notations of deviations from the contract documents
 - i. Other pertinent data
 - j. Provide space for Contractor's review stamps
3. Composition:
- a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
 - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
 - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; electrical power criteria (e.g., voltage, phase, amps, horsepower, kW, etc.) wiring and control diagrams; Short Circuit Current Rating (SCCR); dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
5. Contractor's Approval Stamp:
- a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
 - b. Unstamped submittals will be rejected.
 - c. The Contractor's review shall include, but not be limited to, verification of the following:
 - 1) Only approved manufacturers are used.
 - 2) Addenda items have been incorporated.
 - 3) Catalog numbers and options match those specified.
 - 4) Performance data matches that specified.
 - 5) Electrical characteristics and loads match those specified.
 - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
 - 7) Dimensions and service clearances are suitable for the intended location.

- 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
 - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
- d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
 - e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
6. Submittal Identification and Markings:
- a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
 - b. The Contractor shall clearly indicate the size, finish, material, etc.
 - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
 - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
 8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
 9. Reproduction of contract documents alone is not acceptable for submittals.
 10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
 11. Submittals not required by the contract documents may be returned without review.
 12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
 13. Submittals shall be reviewed and approved by the Architect/Engineer before releasing any equipment for manufacture or shipment.
 14. Contractor's responsibility for errors, omissions, or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
 15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
 - a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.
16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. Submittal file name: 23 XX XX.description.YYYYMMDD
 - b. Transmittal file name: 23 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.5 CHANGE ORDERS

- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.
- B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.
- C. Change order work shall not proceed until authorized.

1.6 EQUIPMENT SUPPLIERS' INSPECTION

- A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:
 1. Split System Air Condition Units
 2. Condensing Units
 3. Rooftop Units
 4. Rooftop Unit Packaged Controls
- B. Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.
- C. Submit copies of start-up reports to the Architect/Engineer and include copies of Owner's Operation and Maintenance Manuals.

1.7 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.
- B. Keep all bearings properly lubricated and all belts properly tensioned and aligned.
- C. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

1.8 NETWORK / INTERNET CONNECTED EQUIPMENT

- A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.9 WARRANTY

- A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.
- B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

1.10 INSURANCE

- A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

1.11 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the scheduled manufacturer is the basis for job design and establishes the quality required.
- B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections, piping and ductwork connections and arrangement, plumbing connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.
- D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractors part or on the part of other Contractors whose work is affected.
- E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.
- F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

1.12 LEED REQUIREMENTS

- A. This project is pursuing a LEED Silver certification in accordance with USGBC LEED Rating System for New Construction v4. The Contractor shall provide all services and documentation necessary to achieve this rating.
- B. The points being attempted for this project are:
 - 1. Energy and Atmosphere : Optimize Energy performance
 - 2. Indoor Environment Quality: Thermal Comfort

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 ARCHITECT/ENGINEER OBSERVATION OF WORK

- A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:
1. Placing fill over underground and underslab utilities.
 2. Covering exterior walls, interior partitions and chases.
 3. Installing hard or suspended ceilings and soffits.
- B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.
- C. Above-Ceiling Final Observation
1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
 - a. Pipe insulation is installed and fully sealed.
 - b. Pipe and duct wall penetrations are sealed.
 - c. Pipe identification and valve tags are installed.
 - d. Main, branch and flexible ducts are installed.
 - e. Diffusers, registers and grilles are installed and connected to ductwork.
 - f. Terminal air box reheat coil wiring is complete.
 - g. Terminal air box control wiring is complete and all control boxes are closed.
 2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
 3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

3.3 PROJECT CLOSEOUT

- A. The following paragraphs supplement the requirements of Division 01.
- B. Final Jobsite Observation:
 - 1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
 - 2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.
 - 3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
 - 4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.
- C. Before final payment is authorized, this Contractor must submit the following:
 - 1. Operation and maintenance manuals with copies of approved shop drawings.
 - 2. Record documents including reproducible drawings and specifications.
 - 3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
 - 4. Start-up reports on all equipment requiring a factory installation inspection or start-up.
 - 5. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site; receipt by Architect/Engineer required prior to final payment approval.

3.4 OPERATION AND MAINTENANCE MANUALS

- A. General:
 - 1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
 - 2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.
- B. Electronic Submittal Procedures:
 - 1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
 - 2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.

3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
 4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. O&M file name: O&M.div23.contractor.YYYYMMDD
 - b. Transmittal file name: O&Mtransmittal.div23.contractor.YYYYMMDD
 5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
 6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
 7. All text shall be searchable.
 8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.
- C. Operation and Maintenance Instructions shall include:
1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
 2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
 3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
 4. Refer to Section 23 0900 for additional requirements for Temperature Control submittals.
 5. Copy of final approved test and balance reports.
 6. Copies of all factory inspections and/or equipment startup reports.
 7. Copies of warranties.
 8. Schematic electrical power/controls wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
 9. Dimensional drawings of equipment.
 10. Capacities and utility consumption of equipment.
 11. Detailed parts lists with lists of suppliers.
 12. Operating procedures for each system.
 13. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
 14. Repair procedures for major components.
 15. List of lubricants in all equipment and recommended frequency of lubrication.

3.5 INSTRUCTING THE OWNER'S REPRESENTATIVES

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.
- D. The instructions shall include:
 - 1. Explanation of all system flow diagrams.
 - 2. Explanation of all air handling systems.
 - 3. Temperature control system operation including calibration, adjustment and proper operating conditions of all sensors.
 - 4. Maintenance of equipment.
 - 5. Start-up procedures for all major equipment.
 - 6. Explanation of seasonal system changes.
 - 7. Description of emergency system operation.
- E. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can attend if desired.
- F. Minimum hours of instruction for each item shall be:
 - 1. Air Handling Systems - 8hours.
 - 2. Exhaust Systems - 8hours.
 - 3. Temperature Controls - As defined in Section 23 0900.
- G. The Contractor shall prepare a detailed, written training agenda and submit it to the Architect/Engineer a minimum of two weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts, etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.
- H. Operating Instructions:
 - 1. Contractor is responsible for all instructions to the Owner's representatives for the mechanical and control systems.
 - 2. If the Contractor does not have staff that can adequately provide the required instructions the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.6 SYSTEM STARTING AND ADJUSTING

- A. The mechanical systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final comfort adjustments as required.
- B. Complete all manufacturer-recommended startup procedures and checklists to verify proper motor rotation, electrical power voltage is within equipment limitations, equipment controls maintain pressures and temperatures within acceptable ranges, all filters and protective guards are in-place, acceptable access is provided for maintenance and servicing, and equipment operation does not pose a danger to personnel or property.
- C. Operate all HVAC systems continuously for at least one week prior to occupancy to bring construction materials to suitable moisture levels. Areas with mechanical cooling shall be maintained below 60% RH.
- D. Contractor shall adjust the mechanical systems and controls at season changes during the one year warranty period, as required, to provide satisfactory operation and to prove performance of all systems in all seasons.
- E. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.
- F. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.7 RECORD DOCUMENTS

- A. The following paragraphs supplement Division 01 requirements.
- B. Maintain at the job site a separate and complete set of mechanical drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.
- C. Mark drawings to indicate revisions to piping and ductwork, size and location, both exterior and interior; including locations of coils, dampers, other control devices, filters, and other units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (e.g., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.
- D. Refer to Section 23 0900 for additional requirements for Temperature Control documents.

- E. Before completion of the project, a set of reproducible mechanical drawings will be given to the Contractor for transfer of all as-built conditions from the paper set maintained at the job site. All marks on reproducibles shall be clear and permanent.
- F. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.
- G. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.
- H. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

3.8 PAINTING

- A. This Contractor shall paint the following items:
 - 1. All piping in mechanical room
- B. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.
- C. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, the Contractor shall have the equipment and all its supports, hangers, etc., painted to match the room decor.
- D. Equipment cabinets, casings, covers, metal jackets, etc., in equipment rooms or concealed spaces, shall be furnished in standard or prime finish, free from scratches, abrasions, chips, etc.
- E. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chips, etc. If color option is specified or is standard to the unit, this Contractor shall, before ordering, verify with the Architect/Engineer the color preference and furnish this color.
- F. Paint all equipment in unfinished areas such as boiler room, mechanical spaces, storage room, etc., furnished by this Contractor. Equipment furnished with a factory coat of paint and enamel need not be painted, provided the factory applied finish is not marred or spattered. If so, equipment shall be refinished with the same paint as was factory applied.
- G. Paint all outdoor uninsulated steel piping the color selected by Owner or Architect/Engineer.
- H. After surfaces have been thoroughly cleaned and are free of oil, dirt, and other foreign matter; paint all pipes and equipment with the following:
 - 1. Bare Metal Surfaces - Apply one coat of primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.
 - 2. Insulated Surfaces - Paint insulation jackets with two coats of semi-gloss acrylic latex paint.

3.9 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.
- B. Clean all drain pans and areas where moisture is present. Immediately report any mold, biological growth, or water damage.
- C. Remove all rust, scale, dirt, oils, stickers and thoroughly clean exterior of all exposed bare metal ductwork, piping, hangers, and accessories.
- D. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.10 SPECIAL REQUIREMENTS

- A. Contractor shall coordinate the installation of all equipment, valves, dampers, operators, etc., with other trades to maintain clear access area for servicing.
- B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

3.11 IAQ MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

- A. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:
 - 1. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:
 - a. Minimizing the amount of dust generated.
 - b. Reducing solvent fumes and VOC emissions.
 - c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.
 - d. Protect stored on-site and installed absorptive materials from moisture damage.
 - 2. Request that the Owner designate an IAQ representative.
 - 3. Review and receive approval from the Owner's IAQ representative for all IAQ-related construction activities and negative pressure containment plans.
 - 4. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.
 - 5. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.
 - 6. Request copies of and follow all of the Owner's IAQ and infection control policies.

7. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.
8. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.
9. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings Under Construction".
10. If permanently installed air handlers are used to serve both construction and occupied areas, all return grilles throughout construction areas shall be sealed to prevent air from construction areas being supplied to occupied areas.
11. If permanently installed air handlers are used during construction to serve only construction areas and do not supply air to adjacent occupied areas, MERV 8 filtration media shall be used to protect each return air grille or opening. The intent of this will be to prevent construction dust and debris from entering any return or supply air ductwork in the facility. All filtration media shall be replaced immediately prior to occupancy.
12. Construction areas shall be maintained at a negative pressure at all times during construction. When areas are under construction, HEPA filtered exhaust fan(s) shall be installed in sufficient quantities as required to maintain construction areas at sufficient negative pressure as called for in the Owner's Infection Control Risk Assessment (ICRA). HEPA filtered exhaust fan discharge shall be ducted either outdoors or back into designated hospital areas as called for in the Owner's ICRA.
13. For each area under construction, the Contractor shall install a negative pressure indicator equivalent to Lamiflow Model L-102F as manufactured by Lamiflow Technologies. Contractor shall regularly monitor and record the negative pressure condition of the construction areas as called for in the Owner's ICRA.

3.12 MAINTAINING CLEAN DUCTWORK THROUGHOUT CONSTRUCTION

- A. Throughout the duration of construction, all ductwork shall be capped or sealed with sheet metal caps, polyethylene film, or other airtight protective to keep dust, dirt, and construction debris out of ducts. Similar means shall be used to seal air-side connections of HVAC equipment to include, but not limited to, air handling units, fans, terminal air boxes, fan coil units, cabinet heaters, blower coils, and the like.
- B. When air terminal devices are installed, contractors shall seal all supply, return, and exhaust grilles with polyethylene film or other airtight protective to keep dust, dirt, and construction debris out of ducts.
- C. Should HVAC equipment be started during construction, Contractor shall remove airtight protectives and shall install one-inch thick MERV 8 filter media over all return and exhaust grilles to prevent dust, dirt, and construction debris from entering ductwork. Filter media shall cover the entire grille face and shall be secured such that air cannot bypass filter media.
- D. Should filter media become laden with dust and dirt, Contractor shall replace filter media with new media to prevent damage to air distribution system and equipment.
- E. The following steps shall be taken during testing, adjusting, and balancing of each air system:
 1. All construction activities in all spaces served by the air system shall stop.
 2. All airtight protectives and temporary filter media shall be removed from all portions of the air system.

3. Testing, adjusting, and balancing work shall not commence until all construction activity is stopped and all airtight protectives and temporary filter media is removed.
4. Once testing, adjusting, and balancing work is complete for the air system, airtight protectives or temporary filter media shall be installed over all ductwork openings and air terminals on the air system prior to resuming construction activities in any spaces served by the air system.

- F. The Owner shall agree the building is sufficiently clean prior to the removal of any filtration media and airtight protectives from air terminal devices.

3.13 CONSTRUCTION WASTE MANAGEMENT

- A. This Contractor shall comply with all construction and demolition waste disposal and recycling requirements outlined in LEED MRc2: Construction Waste Management (follow latest edition at the time of bidding or as referenced in these specifications).

1. This Contractor shall coordinate with the General Contractor to develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on-site or co-mingled.
2. The Contractor shall track waste disposal and recycling efforts throughout the construction process for all materials associated with this Contractor's scope of work. The Contractor shall provide this information to the General Contractor so that it can be incorporated with similar information from all other contractors for the project.
 - a. Calculations for waste and recycled material can be done by weight or volume, but they must be consistent throughout the project. The Contractor shall coordinate with the General Contractor to establish the preferred calculation method and report the results accordingly.
 - b. Excavated soil and land-clearing debris do not count towards the waste disposal or recycled material.
3. At a minimum, 50% of the construction and demolition debris for this project must be recycled or salvaged.

3.14 UTILITY REBATE

- A. Submit utility rebate forms, where offered at project location, with rebate items completed. Rebate may include lighting, lighting controls, variable speed drives, heat pumps, package terminal A/C, air conditioners, chillers, water heaters, programmable thermostats, and motors.

- B. Contractor must submit notification of any value engineering or product substitution that will affect the utility rebate amount prior to approval.

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

1. Penetrations fire sealed and labeled in accordance with specifications.
2. All air handling units operating and balanced.

3. All fans shall be operating and balanced.
5. All miscellaneous mechanical systems (unit heaters, fan coil units, cabinet heaters, etc.) operating.
6. All temperature control systems operating, programmed and calibrated.
7. Pipe insulation complete, pipes labeled and valves tagged.

Accepted by:

Prime Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION

SECTION 23 0529 - HVAC SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Hangers, Supports, and Associated Anchors.
- B. Sleeves and Seals.
- C. Flashing and Sealing of Equipment and Pipe Stacks.
- D. Cutting of Openings.

1.2 REFERENCES

- A. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- B. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
- C. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.3 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

- A. Furnish sleeves and hanger inserts to General Contractor for placement into formwork.

PART 2 - PRODUCTS

2.1 HANGER RODS

- A. Hanger rods for single rod hangers shall conform to the following:

Pipe Size	Hanger Rod Diameter	
	Column #1	Column #2
2-1/2" and smaller	3/8"	3/8"

Column #1: Steel pipe.

Column #2: Copper, plastic and fiberglass reinforced pipe.

- B. Rods for double rod hangers may be reduced one size. Minimum rod diameter is 3/8 inches.
- C. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
- D. All hanger rods, nuts, washers, clevises, etc., in damp areas shall have ASTM A123 hot-dip galvanized finish applied after fabrication. This applies to the following areas:

2.2 PIPE AND STRUCTURAL SUPPORTS

A. General:

1. Pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS SP-58, 69, 89, and 127 (where applicable).
2. On all insulated piping, provide at each support an insert of same thickness and contour as adjoining insulation, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Refer to insulation specifications for materials and additional information.

B. Hangers and Clamps:

1. Oversize all hangers, clamps, and supports on insulated piping to allow insulation and jacket to pass through unbroken. This applies to both hot and cold pipes.
2. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp within their temperature limits of -65°F to +275°F.
3. On all insulated piping, provide a semi-cylindrical metallic shield and vapor barrier jacket.
4. Unless otherwise indicated, hangers shall be as follows:
 - a. Clevis Type: Service: Bare Metal Pipe or Insulated Cold Pipe - 3 inches and Smaller:
 - 1) Products: Insulated Pipe:
 - a) Anvil Fig. 260
 - b) Cooper/B-Line Fig. 3100
 - c) Erico Model 400
 - d) Nibco/Tolco Fig. 1
5. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.
 - a. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
 - b. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.
6. Unless otherwise indicated, pipe supports for use with struts shall be as follows:
 - a. Clamp Type: Service: or Insulated Cold Pipe - 3 inches and smaller:
 - 1) Clamps in direct contact with copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp.
 - 2) Pipes subject to expansion and contraction shall have clamps oversized to allow limited pipe movement.

- 3) Products: Insulated Pipe:
 - a) Unistrut Fig. P1100 or P2500
 - b) Cooper/B-Line Fig. B2000 or B2400
 - c) Nibco/Tolco Fig. A-14 or 2STR

C. Upper (Structural) Attachments:

1. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:

- a. Steel Structure Clamps: C-Type Wide Flange Beam Clamps (for use on top and/or bottom of wide flanges. Not permitted for use with bar-joists.):

- 1) Products:
 - a) Anvil Fig. 92
 - b) Cooper/B-Line Fig. B3033/B3034
 - c) Erico Model 300
 - d) Nibco/Tolco 68

- b. Scissor Type Beam Clamps (for use with bar-joists and wide flange):

- 1) Products:
 - a) Anvil Fig. 228, 292
 - b) Cooper/B-Line Fig. B3054
 - c) Erico Model 360
 - d) Nibco/Tolco Fig. 329

- c. Concentrically Loaded Open Web Joist Hangers (for use with bar joists):

- 1) Products:
 - a) MCL. M1, M2 or M3

- d. Steel Structure Welding:

- 1) Unless otherwise noted, hangers, clips, and auxiliary support steel may be welded in lieu of bolting, clamping, or riveting to the building structural frame. Take adequate precautions during all welding operations for fire prevention and protecting walls and ceilings from smoke damage.

2.3 FOUNDATIONS, BASES, AND SUPPORTS

A. Basic Requirements:

1. Furnish and install foundations, bases, and supports (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for mechanical equipment.

B. Supports:

1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.
2. Hang heavy equipment from concrete floors or ceilings with Architect/Engineer-approved concrete inserts, furnished and installed by the Contractor whose work requires them, except where indicated otherwise.

2.4 OPENINGS IN FLOORS, WALLS AND CEILINGS

- A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the General Contractor for installation or construction as the structure is built.
- B. Coordinate all openings with other Contractors.
- C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.
- D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at Contractor's expense.
- E. Do not cut structural members without written approval of the Architect or Structural Engineer.

2.5 ROOF PENETRATIONS

- A. Roof Curb Enclosure: Provide weatherproof roof curb and enclosure for pipe and duct penetrations. Refer to drawings for details.
- B. Conical Pipe Boot: Seal pipes with surface temperature below 150°F penetrating single-ply roofs with conical stepped, UV-resistant silicone, EPDM or neoprene pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots or Pipetite. Color: White shall match roofing material.
- C. Break insulation only at the clamp for pipes between 60°F and 150°F. Seal outdoor insulation edges watertight.

2.6 SLEEVES AND LINTELS

- A. Each Contractor shall provide sleeves and lintels for all duct and pipe openings required for the Contractor's work in masonry walls and floors, unless specifically shown as being by others.
- B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.
- C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Architect or Structural Engineer.

- D. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
- E. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Architect/Engineer's design.
- F. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.
- G. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
- H. Where pipes rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (e.g., foam, rubber, asphalt-coated fiber, bituminous-impregnated felt, or cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
- I. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.
- J. Wall Seals ("Link-Seals"):
 - 1. Where shown on the drawings, pipes passing through walls, ceilings, or floors shall have their annular space (sleeve or drilled hole - not tapered hole made with knockout plug) sealed by properly sized sealing elements consisting of a synthetic rubber material compounded to resist aging, ozone, sunlight, water and chemical action.
 - 2. Sleeves, if used, shall be standard weight steel with primed finish and waterstop/anchor continuously welded to sleeve. If piping carries only fluids below 120°F, sleeves may be thermoplastic with integral water seal and textured surface.
 - 3. Sleeves shall be at least 2 pipe sizes larger than the pipes.
 - 4. Pressure shall be maintained by stainless steel bolts and other parts. Pressure plates may be of composite material for Models S and OS.
 - 5. Sealing element shall be as follows:

<u>Model</u>	<u>Service</u>	<u>Element Material</u>	<u>Temperature Range</u>
S	Standard (Stainless)	EPDM	-40°F to 250°F
T	High/Low Temperature (Steam)	Silicone	-67°F to 400°F
T	Fire Seals (1 hour)	Silicone	-67°F to 400°F
FS	Fire Seals (3 hours)	Silicone	-67°F to 400°F
OS	Oil Resistant/Stainless	Nitrile	-40°F to 210°F

- 6. Manufacturers:
 - a. Thunderline Corporation "Link-Seals"
 - b. O-Z/Gedney Company
 - c. Calpico, Inc.
 - d. Innerlynx

- e. Metraflex Company (cold service only)

2.7 ESCUTCHEON PLATES AND TRIM

- A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.
- B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.
- C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes pipe openings.

2.8 PIPE PENETRATIONS

- A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.
- B. Seal fire rated wall and floor penetrations with fire seal system as specified.

2.9 PIPE ANCHORS

- A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.
- B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

2.10 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.1 HVAC SUPPORTS AND ANCHORS

- A. General Installation Requirements:
 - 1. Install all items per manufacturer's instructions.
 - 2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
 - 3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
 - 4. Supports shall extend directly to building structure. Do not support piping from duct hangers unless coordinated with sheet metal contractor prior to installation. Do not allow lighting or ceiling supports to be hung from piping supports.
- B. Supports Requirements:

1. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
 2. Set all concrete inserts in place before pouring concrete.
 3. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
 4. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
 5. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.
- C. Pipe Requirements:
1. Support all piping and equipment, including valves, strainers, traps and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
 2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
 3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
 4. Piping shall not introduce strains or distortion to connected equipment.
 5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
 6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
 7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
 8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.
- D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:
1. Loads of 100 lbs. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.
 2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
 - a. The hanger is attached within 6" from a web/chord joint.
 - b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.
 3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
 4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.
- E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.

- F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.
- H. Steel/Concrete Structure: Spacing of hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:
 - 1. Hard Drawn Copper & Brass (Liquid Service):
 - a. Maximum Spacing:
 - 1) 3/4" and under: 5'-0"
 - 2) 1": 6'-0"
 - 3) 1-1/4": 7'-0"
 - 4) 1-1/2" 8'-0"
 - 5) 2": 8'-0"
 - 6) 2-1/2": 9'-0"
 - 7) 3": 10'-0"
 - 8) 4": 12'-0"
 - 9) 6": 12'-0"
 - 2. Hard Drawn Copper & Brass (Vapor Service):
 - a. Maximum Spacing:
 - 1) 3/4" & under: 7'-0"
 - 2) 1": 8'-0"
 - 3) 1-1/4": 9'-0"
 - 4) 1-1/2": 10'-0"
 - 5) 2": 11'-0"
 - 6) 2-1/2" & larger: 12'-0"
- I. Installation of hangers shall conform to MSS SP-58, 69, and 89.

END OF SECTION

SECTION 23 0553 - HVAC IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Identification of products installed under Division 23.

1.2 REFERENCES

- A. ANSI/ASME A13.1 - Scheme for the Identification of Piping Systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. 3M
- B. Bunting
- C. Calpico
- D. Craftmark
- E. Emedco
- F. Kolbi Industries
- G. Seton
- H. W.H. Brady
- I. Marking Services.

2.2 MATERIALS

- A. All pipe markers (purchased or stenciled) shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

OD of Pipe or Insulation	Marker Length	Size of Letters
Up to and including 1-1/4" (32mm)	8" (200 mm)	1/2" (12 mm)
Plastic tags may be used for outside diameters under 3/4" (20 mm)		

- B. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.

- C. Plastic Tags: Minimum 1-1/2" square or round laminated three-layer phenolic with engraved, 1/4" minimum black letters on light contrasting background.
- D. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.
- E. Ceiling Markers:
 - 1. Label Style:
 - a. The intent is for the ceiling labels to be inconspicuous but easy to find and read while standing underneath. The labels shall be located on the grid T-bar nearest the ceiling tile that can be removed to provide the best access to the serviceable side of equipment or to valves. An arrow can be used to point to the tile needing removal.
 - b. The label tape shall be approximately 1/2" wide with all capitalized letters approximately 3/16" tall.
 - c. Ceiling grid labels shall be made with a label maker with durable adhesive labels having a clear background and black letters.
 - d. Equipment labels shall be as designated on the drawings (e.g., FCU-606B, etc.).
 - e. Fire, fire/smoke and smoke dampers shall be labeled consistent with the type (e.g., Fire Damper, Fire/Smoke Damper, etc.),

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all products per manufacturer's recommendations.
- B. Degrease and clean surfaces to receive adhesive for identification materials.
- C. Pipe Markers:
 - 1. Adhesive Backed Markers: Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.
 - 2. Apply markers and arrows in the following locations where clearly visible:
 - a. On both sides of walls that pipes penetrate.
 - b. At least every 20 feet along all pipes.
 - c. On each riser and each leg of each "T" joint.
 - 3. Underground Pipe Markers: Install 8" to 10" below grade, directly above buried pipes.
- D. Equipment:

1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function such as air handling units, exhaust fans, filters, reheat coils, dampers, etc.; shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.
2. Fasten nameplates or plastic tags with stainless steel self-tapping screws or permanently bonding cement.
3. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE 90.1.

E. Miscellaneous:

1. Attach self-adhesive vinyl labels at all duct access doors used to reset fusible links or actuators on fire, fire/smoke, or smoke dampers. Lettering shall be a minimum of 1/2" high. Labels shall indicate damper type.
2. Provide engraved plastic tags at all hydronic or steam system make-up water meters.

3.2 SCHEDULE

A. Pipes to be marked shall be labeled with text as follows, regardless of which method or material is used:

1. CONDENSATE DRAIN: White lettering; green background
2. REFRIGERANT LIQUID: White lettering; purple background
3. REFRIGERANT SUCTION: White lettering; purple background

END OF SECTION

SECTION 23 0593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Testing, adjusting, and balancing of air systems.
- B. Testing, adjusting, and balancing of heating systems.
- C. Testing, adjusting, and balancing of cooling systems.
- D. Measurement of final operating condition of HVAC systems.

1.2 QUALITY ASSURANCE

- A. Agency shall be a company specializing in the adjusting and balancing of systems specified in this section with minimum three years' experience. Perform work under supervision of AABC Certified Test and Balance Engineer, NEBB Certified Testing, Balancing and Adjusting Supervisor, SMARTA Certified Air and Hydronic Balancer, or TABB Certified Supervisor.
- B. Work shall be performed in accordance with the requirements of the references listed at the start of this section.

1.3 REFERENCES

- A. AABC - National Standards for Total System Balance, Seventh Edition.
- B. ADC - Test Code for Grilles, Registers, and Diffusers.
- C. AMCA - Publication 203-90; Field Performance Measurement of Fan Systems.
- D. ASHRAE - 2019 HVAC Applications Handbook; Chapter 39, Testing, Adjusting and Balancing.
- E. ASHRAE/ANSI - Standard 111-2008; Practices for Measurement, Testing, Adjusting and Balancing of Building HVAC&R Systems.
- F. NEBB - Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems, Ninth Edition, 2019.
- G. SMACNA - HVAC Systems; Testing, Adjusting and Balancing, Third Edition, 2002.
- H. TABB - International Standards for Environmental Systems Balance.

1.4 SUBMITTALS

- A. Submit copies of report forms, balancing procedures, and the name and qualifications of testing and balancing agency for approval within 30 days after award of Contract.

B. Electronic Copies:

1. Submit a certified copy of test reports to the Architect/Engineer for approval. Electronic copies shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Copies that are not legible will be returned to the Contractor for resubmittal. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
2. Electronic file size shall be limited to a maximum of 10MB. Larger files shall be divided into files that are clearly labeled as "1 of 2", "2 of 2", etc.
3. All text shall be searchable.
4. Bookmarks shall be used. All bookmark titles shall be an active link to the index page and index tabs.

1.5 REPORT FORMS

- A. Submit reports on AABC, SMACNA or NEBB forms. Use custom forms approved by the Architect/Engineer when needed to supply specified information.
- B. Include in the final report a schematic drawing showing each system component, including balancing devices, for each system. Each drawing shall be included with the test reports required for that system. The schematic drawings shall identify all testing points and cross-reference these points to the report forms and procedures.
- C. Refer to PART 4 for required reports.

1.6 WARRANTY/GUARANTEE

- A. The TAB Contractor shall include an extended warranty of 90 days after owner receipt of a completed balancing report, during which time the Owner may request a recheck of terminals, or resetting of any outlet, coil, or device listed in the test report. This warranty shall provide a minimum of 24 manhours of onsite service time. If it is determined that the new test results are not within the design criteria, the balancer shall rebalance the system according to design criteria.
- B. Warranty/Guarantee must meet one of the following programs: TABB International Quality Assurance Program, AABC National Project Performance Guarantee, NEBB's Conformance Certification.

1.7 SCHEDULING

- A. Coordinate schedule with other trades. Provide a minimum of seven days' notice to all trades and the Architect/Engineer prior to performing each test.
- B. Project will be constructed in phases. Provide balancing report after each phase is complete.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. All procedures must conform to a published standard listed in the References article of this section. All equipment shall be adjusted in accordance with the manufacturer's recommendations. Any system not listed in this specification but installed under the contract documents shall be balanced using a procedure from a published standard listed in the References article.
- B. The Balancing Contractor shall incorporate all pertinent documented construction changes (e.g. submittals/shop drawings, change orders, RFIs, ASIs, etc.) and include in the balancing report.
- C. Recorded data shall represent actual measured or observed conditions.
- D. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing is complete, close probe holes and patch insulation with new materials as specified. Restore vapor barrier and finish as specified.
- E. Permanently mark setting of valves, dampers, and other adjustment devices allowing for settings to be restored. Set and lock memory stops.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, plugging test holes, and restoring thermostats to specified settings.
- G. The Balancing Contractor shall measure terminal air box air flow, and the TCC shall adjust DDC readout to match. Refer to Section 23 0900 for additional information.
- H. Installations with systems consisting of multiple components shall be balanced with all system components operating.

3.2 EXAMINATION

- A. Before beginning work, verify that systems are complete and operable. Ensure the following:
 - 1. General Equipment Requirements:
 - a. Equipment is safe to operate and in normal condition.
 - b. Equipment with moving parts is properly lubricated.
 - c. Temperature control systems are complete and operable.
 - d. Proper thermal overload protection is in place for electrical equipment.
 - e. Direction of rotation of all fans and pumps is correct.
 - f. Access doors are closed and end caps are in place.
 - 2. Duct System Requirements:
 - a. All filters are clean and in place. If required, install temporary media.

- b. Duct systems are clean and free of debris.
- c. Fire/smoke and manual volume dampers are in place, functional and open.
- d. Air outlets are installed and connected.
- e. Duct system leakage has been minimized.

3. Pipe System Requirements:

- a. Coil fins have been cleaned and combed.
- b. Strainer screens are clean and in place.
- c. Shutoff, throttling and balancing valves are open.

- B. Report any defects or deficiencies to Architect/Engineer.
- C. Promptly report items that are abnormal or prevent proper balancing.
- D. If, for design reasons, system cannot be properly balanced, report as soon as observed.
- E. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to the Architect/Engineer for spot checks during testing.
- B. Instruments shall be calibrated within six months of testing performed for project, or more recently if recommended by the instrument manufacturer.

3.4 INSTALLATION TOLERANCES

- A. $\pm 10\%$ of scheduled values:
 - 1. Adjust air inlets and outlets to $\pm 10\%$ of scheduled values.
- B. $+ 5\%$ of scheduled values
 - 1. Adjust outdoor air intakes to within $+ 5\%$ of scheduled values.
- C. Adjust supply, return, and exhaust air-handling systems to $+10\%$ / -5% of scheduled values.

3.5 ADJUSTING

- A. After adjustment, take measurements to verify balance has not been disrupted or that disruption has been rectified.
- B. Once balancing of systems is complete, at least one damper or valve must be 100% open.
- C. After testing, adjusting and balancing are complete, operate each system and randomly check measurements to verify system is operating as reported in the report. Document any discrepancies.

- D. Contractor responsible for each motor shall also be responsible for replacement sheaves. Coordinate with contractor.

3.6 SUBMISSION OF REPORTS

- A. Fill in test results on appropriate forms.
- B. Complete all applicable tests, certifications, forms, and matrices listed in the Illinois Department of Public Health (IDPH) Final Occupancy Checklist Certifications for Request of Inspection.

PART 4 - SYSTEMS TO BE TESTED, ADJUSTED AND BALANCED

4.1 GENERAL REQUIREMENTS

- A. Title Page:
 - 1. Project name.
 - 2. Project location.
 - 3. Project Architect.
 - 4. Project Engineer (IMEG Corp.).
 - 5. Project General Contractor.
 - 6. TAB Company name, address, phone number.
 - 7. TAB Supervisor's name and certification number.
 - 8. TAB Supervisor's signature and date.
 - 9. Report date.
- B. Report Index
- C. General Information:
 - 1. Test conditions.
 - 2. Nomenclature used throughout report.
 - 3. Notable system characteristics/discrepancies from design.
 - 4. Test standards followed.
 - 5. Any deficiencies noted.
 - 6. Quality assurance statement.
- D. Instrument List:
 - 1. Instrument.
 - 2. Manufacturer, model, and serial number.
 - 3. Range.
 - 4. Calibration date.

4.2 AIR SYSTEMS

- A. Duct Leakage Test:
 - 1. Air system and fan.

2. Leakage class.
3. Test pressure.
4. Construction pressure.
5. Flow rate (cfm): specified and actual.
6. Leakage (refer to Section 23 3100 in the specifications): specified and actual.
7. Statement that fire dampers, reheat coils and other accessories were included in the test.
8. Pass or Fail.
9. Test performed by.
10. Test witnessed by.

B. Air Moving Equipment:

1. General Requirements:
 - a. Drawing symbol.
 - b. Location.
 - c. Manufacturer, model, arrangement, class, discharge.
 - d. Fan RPM.
 - e. Multiple RPM fan curve with operating point marked. (Obtain from equipment supplier).
 - f. Final frequency of motor at maximum flow rate (on fans driven by VFD).
2. Flow Rate:
 - a. Supply flow rate (cfm): specified and actual.
 - b. Return flow rate (cfm): specified and actual.
 - c. Outside flow rate (cfm): specified and actual.
 - d. Exhaust flow rate (cfm): specified and actual.
3. Pressure Drop and Pressure:
 - a. Filter pressure drop: specified and actual.
 - b. Total static pressure: specified and actual. (Indicate if across fan or external to unit).
 - c. Inlet pressure.
 - d. Discharge pressure.

C. Fan Data:

1. Drawing symbol.
2. Location.
3. Manufacturer and model.
4. Flow rate (cfm): specified and actual.
5. Total static pressure: specified and actual. (Indicate measurement locations).
6. Inlet pressure.
7. Discharge pressure.
8. Fan RPM.

D. Electric Motors:

1. Drawing symbol of equipment served.

2. Manufacturer, Model, Frame.
 3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
 4. Measured: Amps in each phase.
- E. Air Terminal (Inlet or Outlet):
1. Drawing symbol.
 2. Room number/location.
 3. Terminal type and size.
 4. Velocity: specified and actual.
 5. Flow rate (cfm): specified and actual.
 6. Percent of design flow rate.
- F. Air Terminal Unit (Terminal Air Box) Data:
1. General Requirements:
 - a. Drawing symbol.
 - b. Location.
 - c. Manufacturer and model.
 - d. Size.
 - e. Type: constant, variable, single, dual duct.
 2. Flow Rate:
 - a. Cooling maximum flow rate (cfm): specified and actual.
 - b. Heating maximum flow rate (cfm): specified and actual.
 - c. Minimum flow rate (cfm): specified and actual.
 3. Temperature:
 - a. Entering air temperature: specified and actual.
 - b. Leaving air temperature (in minimum airflow/heating mode): specified and actual.
 4. Pressure Drop and Pressure:
 - a. Inlet static pressure during testing cooling maximum airflow rate (maximum and minimum).
 - b. Water pressure drop: specified and actual.
- G. LEED Air Contaminant Flushout
1. In accordance with LEED EQc3.2 Option 1, the Contractor shall perform a building flushout of air contaminants. The flushout must follow either Path 1 or Path 2 as outlined below. The Contractor shall coordinate with all other trades, the General Contractor, and the Owner to determine the time required and scheduling for the flushout. The Contractor shall keep records documenting the flushout process and submit them to the Architect and Engineer when the process is complete.

- a. Path 1 - Pre-Occupancy Flushout: After construction is complete and prior to occupancy and with all interior finishes installed, install new filtration media and perform a flushout by supplying a total air volume of 14,000 cubic feet. of outdoor air per square foot of floor area while maintaining an internal temperature of at least 60°F and relative humidity no higher than 60%.
- b. Path 2 - Occupied Flushout: The space may be occupied after delivering a minimum of 3,500 cubic feet. of outdoor air per square foot of floor area (in accordance with the requirements listed in Path 1). Once the space is occupied, it must be ventilated at a minimum rate of 0.30 CFM/SF of outdoor air or the scheduled design minimum outside airflow rate, whichever is greater. During each day of the flushout period, ventilation must begin a minimum of 3 hours prior to occupancy and continue during occupancy. These conditions must be maintained until a total of 14,000 cubic feet. per square foot of outside air has been delivered to the space.

H. LEED IAQ Testing

1. In accordance with LEED EQc3.2 Option 2, the Contractor shall perform baseline IAQ testing after construction ends and prior to occupancy. The Contractor shall coordinate with all other trades, the General Contractor, and the Owner to determine the time required and scheduling for the IAQ testing. The Contractor shall keep records documenting the IAQ testing process and submit them to the Architect and Engineer when the process is complete. The IAQ testing protocols utilized must be consistent with either the EPA Compendium of Methods for the Determination of Air Pollutants in Indoor Air or the ISO method listed below. Testing must be done in accordance with one standard; the requirements of both standards cannot be mixed.
 - a. ISO Method: Demonstrate that the contaminant maximum concentration levels as listed in the appropriate LEED Standard and associated Reference Guide (with addenda) are not exceeded.
2. For each sampling point where the maximum concentration limits are exceeded, conduct an additional flushout with outside air and retest the noncompliant concentrations. Repeat until all requirements are met. When retesting non-compliant areas, take samples from the same locations as in the first test.
3. Conduct the air sample testing per the following:
 - a. All measurements must be conducted prior to occupancy, but during normal occupied hours, with the building ventilation system started at the normal daily start time and operated at the minimum outside airflow rate for the occupied mode throughout the test.
 - b. All interior finishes must be installed including, but not limited to, millwork, doors, paint, carpet, and acoustic tiles. Movable furnishings such as workstations and partitions should be in place for the testing.
 - c. The number of sampling locations must include the entire building and all representative situations. Samples shall be taken from each portion of the building served by a separate ventilation system, with the number of points samples not less than 1 per 25,000 square feet or for each contiguous floor area, whichever is larger. Include areas with the least ventilation and greatest presumed source strength.

- d. Air samples must be collected between 3 and 6 feet from the floor to represent the breathing zone of occupants, and over a minimum 4-hour period.

4.3 HEATING SYSTEMS

A. Terminal Heat Transfer Units:

- 1. General Requirement:
 - a. Drawing symbol.
 - b. Location.
 - c. Manufacturer and model.
 - d. Include air data only for forced air units.
- 2. Flow Rate:
 - a. Flow rate (cfm): specified and actual.
- 3. Temperature:
 - a. Entering air temperature: specified and actual.
 - b. Leaving air temperature: specified and actual.

END OF SECTION

SECTION 23 0713 - DUCTWORK INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Ductwork Insulation.
- B. Insulation Jackets.

1.2 QUALITY ASSURANCE

- A. Applicator: Company specializing in ductwork insulation application with five years minimum experience. When requested, installer shall submit manufacturer's certificate indicating qualifications.
- B. Materials:
 - 1. Listed and labeled for flame spread/smoke developed rating of no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.
 - 2. Fungal Resistance: No growth when tested in accordance with ASTM G21 (antifungal test).
 - 3. Rated velocity on coated air side for air erosion in accordance with UL 181 at 5,000 fpm minimum.
 - 4. UL listed in Category HNKT.
- C. Adhesives: UL listed, meeting NFPA 90A/90B requirements.

1.3 REFERENCES

- A. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- B. ANSI/ASTM C553 - Mineral Fiber Blanket and Felt Insulation.
- C. ANSI/ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.
- D. ASTM E84 - Surface Burning Characteristics of Building Materials.
- E. ASTM E136 - Standard Test Method for the Behavior of Materials in a Vertical Tube Furnace at 750°C.
- F. ASTM E814 - Fire Tests of Through Penetrations Firestops.
- G. ASTM E2336-04 - Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems.
- H. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

- I. National Commercial & Industrial Insulation Standards - 1999 Edition - as published by Midwest Insulation Contractors Association and endorsed by National Insulation Contractors Association.
- J. NFPA 96 - Standard for the Installation of Equipment for Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment.
- K. NFPA 255 - Surface Burning Characteristics of Building Materials.
- L. UL - XHEZ - Through Penetration Firestop Systems.
- M. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.
- N. UL 263 - Full Scale External Fire Tests with Hose Stream.
- O. UL 723 - Surface Burning Characteristics of Building Materials.
- P. UL 1479 - Fire Tests of Through Penetrations Firestops.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Type A: Flexible Fiberglass - Outside Wrap; ANSI/ASTM C553; commercial grade; 0.28 / 0.26 (Out-Of-Package/Installed-Compressed 25%) maximum 'K' value at 75°F; foil scrim Kraft facing, 1.0 lb./cu. ft. density. Submit both "Out of Package" and "Installed-Compressed 25%" K and R-values.
- B. Type C: Flexible Fiberglass Liner; ANSI/ASTM C1071; 0.28 maximum 'K' value at 75°F; 1.5 lb/cu ft minimum density; coated air side for 5000 fpm air velocity.

TYPE	K-FACTOR	R-VALUE PER THICKNESS							
		THICKNESS	0.5	1	1.5	2	2.5	3	4
Flexible Fiberglass Outside Wrap	0.28			5.4	7.1	8.9	10.7	14.3	17.9
Semi-Rigid Fiberglass Board Wrap	0.25			6.0	8.0	10.0	12.0	16.0	20.0
Flexible Fiberglass Liner	0.28	1.8	3.6	5.4	7.1	8.9	10.7	14.3	17.9
Rigid fiberglass liner Double Wall	0.23		4.3	6.5	8.7	10.9	13.0	17.4	21.7
Ductwork	0.27		3.7	5.6	7.4	9.3	11.1	14.8	18.5
Flexible High Temp Rigid Preformed Fiberglass Acoustical Liner	0.23		4.3	6.5	8.7	10.9	13.0	17.4	21.7

2.2 JACKETS

- A. Vapor Barrier Jackets: Kraft reinforced foil scrim vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 25 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions, codes, and industry standards.
- B. Install materials after ductwork has been tested.
- C. Clean surfaces for adhesives.
- D. Provide insulation with vapor barrier when air conveyed may be below ambient temperature.
- E. Exterior Duct Wrap - Flexible, Type A:
 - 1. Apply with edges tightly butted.
 - 2. Cut slightly longer than perimeter of duct to insure full thickness at corners. Do not wrap excessively tight.
 - 3. Seal joints with adhesive backed tape.
 - 4. Apply so insulation conforms uniformly and firmly to duct.
 - 5. Seal all penetrations of the vapor barrier by strap hangers or slip cable hangers with adhesive backed tape.
 - 6. Provide high-density insulation inserts on rectangular ducts at trapeze duct hangers to prevent crushing of insulation. Provide high-density insulation inserts with clamp-on round ducts requiring two (2) rods or straps to prevent crushing of insulation. Maintain continuous vapor barrier through the hanger.
 - 7. Tape all joints with Royal Tapes #RT 350 (216-439-7229), Venture Tape 1525CW, or Compac Type FSK. No substitutions will be accepted without written permission from the Architect/Engineer.
 - 8. Press tape tightly to the duct covering with a squeegee for a tight continuous seal. Fish mouths and loose tape edges are not acceptable.
 - 9. Staples may be used, but must be covered with tape.
 - 10. Vapor barrier must be continuous.
 - 11. Mechanically fasten on 12" centers at bottom of ducts over 24" wide and on all sides of vertical ducts.
- F. Interior Insulation - Flexible Duct Liner, Type C:
 - 1. Observation of Duct Lining:
 - a. After installation of ductwork, Architect/Engineer may select random observation points in each system.

- 1) At each observation point, cut and remove an 18" x 18" section of ductwork and liner for verification of installation.
- 2) Random observation points based on one opening per 75 lineal ft. of total duct run.
 - b. When any of the observation points shows non-compliance, additional points will be designated by the Architect/Engineer, and observation repeated.
 - c. If 20% of points observed do not comply, remove and replace all lined ducts and repeat tests. Where replacement is not required, correct all non-compliances.
 - d. At end of observation, repair all duct lining and observation holes by installing standard, insulated, hinged access doors per Section 23 3300.
 - e. Paint or finish to match adjacent duct surfaces.
2. Impale on spindle anchors welded or mechanically fastened to the duct. Adhesive or glue fastened anchors are not acceptable. Maximum anchor spacing per SMACNA Duct Construction Standards or manufacturer's recommendations, whichever is more restrictive. Locate pins less than 3" from corners and at intervals not over 6" around the perimeter at leading and trailing edges. Locate pins within 3" of transverse joints and at intervals not over 16" long the length of the duct. Pins must be long enough to prevent compressing the insulation.
3. In addition to anchors, secure liner with UL listed adhesive covering over 90% of the duct surface.
4. Install per the latest edition of the SMACNA Manual.
5. Leading edges shall be covered as follows:
 - a. For duct velocities below 3000 fpm, coat leading edges with adhesive. Neatly butt liner without gaps at transverse joints. Cut liner flush with end of the duct section for tight joints with no exposed duct. If adhesive is shop installed, field apply additional adhesive to the end of each duct section for complete adhesion of the liner. Protect edges from dirt and debris.
 - b. For duct velocities above 3000 fpm, cover leading edges with metal nosing. Use nosing on upstream edges of each section of duct. If the duct can be installed in either direction, provide nosing on each end or clearly mark the duct to allow visual verification after installation. Verify duct velocities based on the scheduled air flow rates and determine where metal nosing is required.
 - c. Install metal nosing in the following locations (regardless of velocity):
 - 1) The first three fittings downstream of all fans.
 - 2) At all duct liner interruptions. This includes fire dampers, access doors, branch connections, and all other locations where the edge of the liner is exposed.
 - 3) Trailing edges of transverse joints do not require metal nosings.
6. Overlap liner at longitudinal joints. Make longitudinal joints at corners of the duct unless the duct size does not allow this. Coat longitudinal joints with adhesive at velocities over 2500 fpm.
7. Seal all damaged duct liner with adhesive and glass cloth. Do not damage duct liner surface coatings.
8. Duct dimensions given are net inside dimensions. Increase sheet metal to allow for insulation thickness.

- G. Continue insulation with vapor barrier through penetrations unless code prohibits.
- H. Provide 2" wide, 24" high, 26 gauge, galvanized sheet metal corner protection angles for all externally insulated ductwork extending to a floor or curb.

3.2 SCHEDULE

- A. Refer to Section 23 3100 for scheduling of insulation.

END OF SECTION

SECTION 230800 - COMMISSIONING OF HVAC

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. Section includes commissioning process requirements for Heating Ventilating Air Conditioning and Refrigeration (HVAC&R) systems, assemblies, and equipment.
- B. Provide documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel. Work with the Commissioning Authority and in cooperation with other members of the commissioning team to ensure compliance.
- C. Refer to Section 019113 GENERAL COMMISSIONING REQUIREMENTS for commissioning requirements.
- D. Related Sections:
 - 1. Division 01 Section "General Commissioning Requirements" for commissioning process requirements.
 - 2. Division 23 Sections related to Testing, Adjusting and Balancing (TAB).

1.3 COMMISSIONING

- A. This section governs the commissioning of HVAC&R systems.
- B. The following systems and equipment shall be commissioned (*), where applicable.
 - 1. Building Automation System
 - 2. Central Heating and Cooling Plant Equipment
 - 3. Roof Top Units
 - 4. Air Handling Units
 - 5. Terminal Air Units
 - 6. Unit Heaters
 - 7. Exhaust Fans
 - 8. Electric Baseboards
 - 9. Heat Pump Units
 - 10. Hydronic, Refrigerant, Steam and Condensate Piping
 - 11. Pumps
 - 12. Condensate Receivers and Pumps

13. Mechanical Identification
14. Ductwork Construction, Insulation and Testing
15. Split System and Type Cooling System

(*) The above list is not intended to be all-inclusive, but rather a representative summary of the scope of Commissioning services to be provided for HVAC&R categories.

- C. Refer to Division 01. Section 019113, "General Commissioning Requirements" for the Work related to commissioning of these systems.

PART 2 - PRODUCTS: NOT USED

PART 3 - EXECUTION: NOT USED

END OF SECTION 230800

SECTION 23 0900 - CONTROLS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Complete System of Automatic Controls.
- B. Control Devices, Components, Wiring and Material.
- C. Instructions for Owners.
- D. Remodeling.

1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum five years' experience.
- B. TCC: Company specializing in the work of this section with minimum five years temperature control experience.
- C. Technician: Minimum five years' experience installing commercial temperature control systems.
- D. TCCs are limited to firms regularly employing a minimum of five full-time temperature control technicians within 100 miles of the job site.

1.3 REFERENCES

- A. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.
- B. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 volts Maximum).
- D. ANSI/NFPA 70 - National Electrical Code.
- E. ANSI/NFPA 90A - Installation of Air-Conditioning and Ventilation Systems.
- F. ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality.
- G. ASHRAE 85 - Automatic Control Terminology for Heating, Ventilating, Air Conditioning.
- H. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- I. ANSI/ASTM B32 - Solder Metal.

J. ASTM B280 - Seamless Copper Tube for Air Conditioning & Refrigeration Field Service.

K. ASTM D1693 - Environmental Stress - Cracking of Ethylene Plastics.

1.4 SUBMITTALS

A. Equipment Coordination:

1. The Controls Contractor shall obtain approved equipment submittals from other contractors to determine equipment wiring connections, to choose appropriate controllers, and to provide programming.
2. Control valve selections shall be based on flow rates shown in approved shop drawings.
3. Coordinate the control interface of all equipment with the equipment manufacturers prior to submittal submission.

B. Shop Drawings:

1. Submit shop drawings per Section 23 0500. In addition, submit an electronic copy of the shop drawings in Adobe Acrobat (.pdf) format to the Owner for review.
2. Cross-reference all control components and point names in a single table located at the beginning of the submittal with the identical nomenclature used in this section.
3. Submittal shall also include a trunk cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media and protocol.
4. System Architecture: Provide riser diagrams of wiring between central control unit and all control panels. This shall include specific protocols associated with each level within the architecture. Identify all interface equipment between CPU and control panels. The architecture shall include interface requirements with other systems including, but not limited to, security systems, lighting control, fire alarm, elevator status, and power monitoring system.
5. Diagrams shall include:
 - a. Wiring diagrams and layouts for each control panel showing all termination numbers.
 - b. Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to the control system.
 - c. Identification of all control components connected to emergency power.
 - d. Schematic diagrams for all field sensors and controllers.
 - e. A schematic diagram of each controlled system. The schematics shall have all control points labeled. The schematics shall graphically show the location of all control elements in the system.
 - f. A schematic wiring diagram for each controlled system. Each schematic shall have all elements labeled. Where a control element is the same as that shown on the control system schematic, label it with the same name. Label all terminals.
 - g. A tabular instrumentation list for each controlled system. The table shall show element name, type of device, manufacturer, model number and product data sheet number.
 - h. All installation details and any other details required to demonstrate that the system will function properly.

- i. All interface requirements with other systems.
6. The network infrastructure shall conform to the published guidelines for wire type, length, number of nodes per channel, termination, and other relevant wiring and infrastructure criteria as published. The number of nodes per channel shall be no more than 80% of the defined segment (logical or physical) limit in order to provide future system enhancement with minimal infrastructure modifications.
 7. Sequences: Submit a complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system. The wording of the control sequences in the submittal shall match verbatim that included in the construction documents to ensure there are no sequence deviations from that intended by the Architect/Engineer. Clearly highlight any deviations from the specified sequences on the submittals.
 8. Points List Schedule: Submit a complete points list of all points to be connected to the TCS and FMCS. The points list for each system controller shall include both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, the location of the I/O device, and reference drawings. Where a control point is the same as that shown on the control system schematic, label it with the same name. Points list shall specifically identify alarms, trends, event history, archive, totalization, graphic points, and all mapped points from other systems (security systems, lighting control, fire alarm, etc.). Provide points lists, point naming convention, and factory support information for systems provided and integrated into the FMCS.
 9. Product Data Sheets: Required for each component that includes: unique identification tag that is consistent throughout the submittal, manufacturer's description, technical data, performance curves, installation/maintenance instructions, and other relevant items. When manufacturer's literature applies to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements.
 10. Provide PICS files indicating the BACnet functionality and configuration of each device.
 11. Provide documentation of submitted products that have been tested and listed by the BACnet Testing Laboratory (BTL), or provide a letter on the manufacturer's company letterhead indicating the anticipated date by which testing is expected to be completed. If, for any reason, BTL testing and listing has not been completed, a written commitment to upgrade installed controls to a version that meets BTL testing and listing requirements if problems are found during BTL testing is required.
 12. Graphic Display: Include a sample graphic of each system and component identified in the points list with a flowchart (site map) indicating how the graphics are to be linked to each other for system navigation.
 13. Control System Demonstration and Acceptance: Provide a description of the proposed process, along with all reports and checklists to be used.
 14. Clearly identify work by others in the submittal.
 15. Quantities of items submitted may be reviewed but are the responsibility of the Contractor to verify.
- C. Operation and Maintenance Manual:

1. In addition to the requirements of Section 23 0500, submit an electronic copy of the O&M manuals in PDF format.
 2. Provide three complete sets of manuals.
 3. Each O&M manual shall include:
 - a. Table of contents with indexed tabs dividing information as outlined below.
 - b. Definitions: List of all abbreviations and technical terms with definitions.
 - c. Warranty Contacts: Names, addresses, and 24-hour telephone numbers of contractors installing equipment and controls and service representatives of each.
 - d. Licenses, Guarantees, and Warranties: Provide documentation for all equipment and systems.
 - e. System Components: Alphabetical list of all system components, with the name, address, and telephone number of the vendor.
 - f. Operating Procedures: Include procedures for operating the control systems; logging on/off; enabling, assigning, and reporting alarms; generating reports; collection, displaying, and archiving of trended data; overriding computer control; event scheduling; backing up software and data files; and changing setpoints and other variables.
 - g. Programming: Description of the programming language (including syntax), statement descriptions (including algorithms and calculations used), point database creation and modification, program creation and modification, and use of the editor.
 - h. Engineering, Installation, and Maintenance: Explain how to design and install new points, panels, and other hardware; recommended preventive maintenance procedures for all system components, including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions; how to debug hardware problems; and how to repair or replace hardware. A list of recommended spare parts.
- D. Training Manual:
1. Provide a course outline and training manuals for each training class.
- E. Record Documents:
1. Submit record documentation per Section 23 0500.
 2. Provide a complete set of "as-built" drawings and application software on CDs. Provide drawings as AutoCAD~~çç~~ or Visio~~çç~~ compatible files. Provide two copies of the "as-built" drawings with revisions clearly indicated in addition to the documents on compact disk. All as-built drawings shall also be installed on the FMCS server in a dedicated directory. Provide all product data sheets in PDF format.
 3. Submit two hard copies and one electronic copy of as-built versions of the shop drawings, including product data and record drawings with revisions clearly indicated. Provide floor plans showing actual locations of control components including panels, thermostats, sensors, and hardware.
 4. Provide all completed testing and commissioning reports and checklists, along with all trend logs for each system identified in the points lists.
 5. Submit printouts of all graphic screens with current values (temperatures, pressures, etc.) to the A/E verifying completion and proper operation of all points.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.
- B. Factory-Mounted Components: Where control devices specified in this section are indicated to be factory mounted on equipment, arrange for shipping control devices to unit manufacturer.

1.6 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Control Valves.
- B. Flow Switches.
- C. Temperature Sensor Sockets.
- D. Gauge Taps.
- E. Automatic Dampers.
- F. Flow Meters.

1.7 ACRONYMS

- A. Acronyms used in this specification are as follows:
 - 1. B-AAC BACnet Advanced Application Controller
 - 2. B-ASC BACnet Application Specific Controller
 - 3. BTL BACnet Testing Laboratories
 - 4. DDC Direct Digital Controls
 - 5. FMCS Facility Management and Control System
 - 6. GUI Graphic User Interface
 - 7. IBC Interoperable BACnet Controller
 - 8. IDC Interoperable Digital Controller
 - 9. LAN Local Area Network
 - 10. NAC Network Area Controller
 - 11. ODBC Open DataBase Connectivity
 - 12. OOT Object Oriented Technology
 - 13. OPC Open Connectivity via Open Standards
 - 14. PICS Product Interoperability Compliance Statement
 - 15. PMI Power Measurement Interface
 - 16. POT Portable Operator's Terminal
 - 17. TCC Temperature Control Contractor
 - 18. TCS Temperature Control System
 - 19. WAN Wide Area Network
 - 20. WBI Web Browser Interface

1.8 SUMMARY

- A. Extend Existing System:
 - 1. Extend the existing FMCS for this project.
 - 2. All controllers and accessories shall interface with the existing FMCS.
- B. TCC shall furnish all labor, materials, equipment, and service necessary for a complete and operating Temperature Control System (TCS) and Facility Management and Control System (FMCS) using Direct Digital Controls as shown on the drawings and as described herein.
- C. All labor, material, equipment and software not specifically referred to herein or on the plans that is required to meet the intent of this specification shall be provided without additional cost to the Owner.
- D. The Owner shall be the named license holder of all software associated with any and all incremental work on the project.

1.9 LEED REQUIREMENTS

- A. This project shall meet the requirements of the U.S. GREEN BUILDING COUNCIL LEADERSHIP IN ENERGY AND ENVIRONMENTAL DESIGN (LEED) program.
- B. This project will attempt to achieve the U.S. Green Building Council's LEED Version 2.2 certification Level: Silver.
- C. This Contractor shall carefully examine the LEED portion of this specification for full compliance with the following LEED points:
 - 1. "Energy & Atmosphere": Prerequisite 1, "Fundamental Building Systems Commissioning," Prerequisite 2 - "Minimum Energy Performance," Credit 3 - "Additional Commissioning," and Credit 5 - "Measurement and Verification," as described by LEED. A complete and total re-commissioning of the TCS may be required at one- and two-year intervals.
 - 2. "Indoor Environmental Quality": Prerequisite 1 - "Minimum IAQ Performance," Credit 1 - "Outdoor Air Delivery Monitoring," Credit 2 - "Increased Ventilation," Credit 6 - "Controllability of Systems," Credit 6.1 - "Lighting Control," and Credit 6.2 - "Thermal Comfort."
 - 3. All labor and materials required for these and any other LEED initiatives shall be provided without additional cost to the Owner.

1.10 SYSTEM DESCRIPTION

- A. The entire TCS shall be comprised of a network of interoperable, standalone digital controllers communicating via the following protocol to an NAC. Temperature Control System products shall be as specified below.
- B. The FMCS shall include Network Area Controller or Controllers (NAC) within each facility. The NAC shall connect to the Owner's local or wide area network, depending on configuration. Provide access to the system, either locally in each building or remotely from a central site or sites, through standard Web browsers, via the Internet, and/or via local area network.

- C. Provide materials and labor necessary to connect factory supplied control components.
- D. Provide central and remote hardware, software, and interconnecting wire and conduit.
- E. The FMCS shall include automated alarming software capable of calling e-mail compatible cellular telephones and pagers. The e-mail alarm paging system shall be able to segregate users, time schedules, and equipment and be capable of being programmed by the Owner.
- F. For the dedicated configuration tool provided, it is preferable that it be launched from within the applicable Network Management Software. If not, include any software required for controller configuration as a leave-behind tool with enough license capability to support the installation.

1.11 JOB CONDITIONS

- A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It is this Contractor's responsibility to check the Contract Documents for possible conflicts between the Work of this section and that of other crafts in equipment location; pipe, duct and conduit runs; electrical outlets and fixtures; air diffusers; and structural and architectural features.

1.12 WARRANTY

- A. Refer to Section 23 0500 for warranty requirements.
- B. Within the warranty period, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by this Contractor at no expense to the Owner.
- C. Warranty requirements include furnishing and installing all FMCS software upgrades issued by the manufacturer during the one-year warranty period.
- D. Update all software and back-ups during warranty period and all user documentation on the Owner's archived software disks.

1.13 WARRANTY ACCESS

- A. The Owner shall grant to this Contractor reasonable access to the TCS and FMCS during the warranty period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. BACnet Protocol:
 - 1. Schneider Electric - EcoStruxure Building Operation (Tiffany Taylor - 708-994-4744)

2.2 SYSTEM ARCHITECTURE

A. General:

1. The Temperature Control System (TCS) and Facility Management Control System (FMCS) shall consist of a network of interoperable, standalone digital controllers, a computer system, graphic user interface software, printers, network devices, valves, dampers, sensors, and other devices as specified herein.
2. The installed system shall provide secure password access to all features, functions and data contained in the overall FMCS.

B. Open, Interoperable, Integrated Architectures:

1. All components and controllers supplied under this Division shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data are not acceptable.
2. The supplied system must be able to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs are not acceptable.
3. Hierarchical or "flat" topologies are required to have system response times as indicated below and to manage the flow and sharing of data without unduly burdening the customer's internal intranet network.
 - a. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
 - b. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

2.3 NETWORKS

A. The Local Area Network (LAN) shall be a 100 megabits/sec Ethernet network supporting BACnet, Java, XML, HTTP, and SOAP. Provide support for multiple Network Area Controllers (NACs), user workstations and, if specified, a local server.

B. Local area network minimum physical and media access requirements:

1. Ethernet; IEEE Standard 802.3.
2. Cable; 100 Base-T, UTP-8 wire, Category 6.
3. Minimum throughput; 100 Mbps.

C. Communication conduits shall not be installed closer than six feet from 110VAC or higher transformers or run parallel within six feet of electrical high-power cables. Route the cable as far from interference generating devices as possible. Where communication wire must cross 110VAC or higher wire, it must do so at right angles.

- D. Ground all shields (earth ground) at one point only to eliminate ground loops. Provide all shield grounding at the controller location, with the shield at the sensor/device end of the applicable wire being left long and "safed" off in an appropriate manner.
- E. There shall be no power wiring more than 30 VAC rms run in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, run all communication wiring and signal wiring using separate twisted pairs (24awg) in accordance with the manufacturer's wiring practices.

2.4 NETWORK AREA CONTROLLER (NAC)

- A. The TCC shall supply one or more Network Area Controllers (NAC) as part of this contract. Number of NACs required depends on the type and quantity of devices provided under Divisions 23 and 26. The TCC shall determine the quantity and type of devices.
- B. Each NAC shall provide the interface between the LAN or WAN and the field control devices and shall provide global supervisory control functions over the control devices connected to the NAC. It shall execute application control programs to provide:
 - 1. Calendar functions.
 - 2. Scheduling.
 - 3. Trending.
 - 4. Alarm monitoring and routing.
 - 5. Time synchronization.
 - 6. Integration of all controller data.
 - 7. Network Management functions.
- C. The Network Area Controller shall provide the following hardware features as a minimum:
 - 1. One Ethernet Port - 10/100 Mbps.
 - 2. One RS-232 port.
 - 3. One LonWorks Interface Port - 78KB FTT-10A (for LonWorks systems only).
 - 4. One RS-485 port.
 - 5. Battery backup.
 - 6. Flash memory for long-term data backup. (If battery backup or flash memory is not supplied, the controller shall contain a hard disk with at least 1 gigabyte storage capacity.)
 - 7. The NAC must be capable of operation over a temperature range of 32°F to 122°F.
 - 8. The NAC must be capable of withstanding storage temperatures of between 0°F and 158°F.
 - 9. The NAC must be capable of operation over a humidity range of 5% RH to 95% RH, non-condensing.
- D. The NAC shall provide multiple user access to the system and support for ODBC or SQL. Databases resident on the NAC shall be ODBC-compliant or must provide an ODBC data access mechanism to read and write data stored within it.
- E. The NAC shall support standard Web browser access via the Internet or an intranet and a minimum of five (5) simultaneous users.
- F. Event Alarm Notification and Actions:

1. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
 2. The NAC shall be able to route any alarm condition to any defined user location whether connected to a LAN, remote via dial-up telephone connection, or WAN.
 3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including, but not limited to:
 - a. Alarm
 - b. Normal
 4. Provide for the creation of a minimum of eight alarm classes with different routing and acknowledgement properties, e.g. security, HVAC, Fire, etc.
 5. Provide timed (scheduled) routing of alarms by class, object, group, or node.
 6. Provide alarm generation from binary object "runtime" and/or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
- G. Treat control equipment and network failures as alarms and annunciated.
- H. Annunciate alarms in any of the following manners as defined by the user:
1. Screen message text.
 2. E-mail of the complete alarm message to multiple recipients. Provide the ability to route and e-mail alarms based on:
 - a. Day of week.
 - b. Time of day.
 - c. Recipient.
 3. Pagers via paging services that initiate a page on receipt of e-mail message.
 4. Graphic with flashing alarm object(s).
 5. Printed message, routed directly to a dedicated alarm printer.
- I. The FMCS shall record the following for each alarm:
1. Time and date.
 2. Location (building, floor, zone, office number, etc.).
 3. Equipment tag.
 4. Acknowledge time, date, and user who issued acknowledgement.
 5. Number of occurrences since last acknowledgement.
- J. Give defined users proper access to acknowledge any alarm.
- K. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.
- L. Provide a "query" feature to allow review of specific alarms by user-defined parameters.
- M. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

- N. An error log to record invalid property changes or commands shall be provided and available for review by the user.

2.5 BACNET FMCS

- A. The intent of this specification is to provide a peer-to-peer networked, standalone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135-2001 BACnet, MODBUS, OPC, and other open and proprietary communication protocols in one open, interoperable system.
- B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices in the system. Adherence to industry standards including the latest ANSI/ASHRAE Standard 135 (BACnet) to assure interoperability between all system components is required. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet (BACnet Ethernet/IP) and/or RS-485 (BACnet MSTP).
- C. Interoperable BACnet Controller (IBC):
 - 1. Controls shall be microprocessor based Interoperable BACnet Controllers (IBC) in accordance with the latest ANSI/ASHRAE Standard 135. Provide IBCs for unit ventilators, fan coils, heat pumps, terminal air boxes (TAB) and other applications. The application control program shall reside in the same enclosure as the input/output circuitry that translates the sensor signals. Provide a PICS document showing the installed system's compliance level to ANSI/ASHRAE Standard 135. Minimum compliance is Level 3.
 - 2. The IBCs shall be listed by the BACnet Testing Laboratory (BTL) as follows:
 - a. BACnet Building Controller(s) (B-BC).
 - b. BACnet Advanced Application Controller(s) (B-ACC).
 - c. BACnet Application Specific Controller(s) (B-ASC).
 - 3. The IBCs shall communicate with the NAC via an Ethernet connection at a baud rate of not less than 10 Mbps.
 - 4. Each IBC sensor shall connect directly to the IBC and shall not use any of the I/O points of the controller. The IBC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The IBC sensor shall provide a communications jack for connection to the BACnet communication trunk to which the IBC controller is connected. The IBC sensor, the connected controller, and all other devices on the BACnet bus shall be accessible by the POT.
 - 5. All IBCs shall be fully application programmable and shall at all times maintain their BACnet Level 3 compliance. Controllers offering application selection only (non-programmable) require a 10% spare point capacity to be provided for all applications. Store all control sequences within or programmed into the IBC in non-volatile memory that does not depend on a battery to be retained.
 - 6. The Contractor supplying the IBCs shall provide documentation for each device, with the following information at a minimum:
 - a. BACnet Device; MAC address, name, type and instance number.
 - b. BACnet Objects; name, type and instance number.

7. It is the responsibility of the Contractor to ensure that the proper BACnet objects are provided in each IBC.

D. Object Libraries:

1. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.
2. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.
3. In addition to the standard libraries specified here, the system supplier shall maintain an on-line accessible (over the Internet) library, available to all registered users, to provide new or updated objects and applications as they are developed.
4. All control objects shall conform to the control objects specified in the BACnet specification.
5. The library shall include applications or objects for the following functions, at a minimum:
 - a. Scheduling Object: The schedule must conform to the schedule object as defined in the BACnet specification, providing seven-day plus holiday and temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphic sliders to speed creation and selection of on-off events.
 - b. Calendar Object: The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphic "point-and-click" selection. This object must be "linkable" to any or all scheduling objects for effective event control.
 - c. Override Object: Provide override object that is capable of restarting equipment turned off by other energy saving programs to maintain occupant comfort or for equipment protection.
 - d. Start-Stop Time Optimization Object: Provide a start-stop time optimization object to start equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled unoccupied time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start-stop time object properties based on historical performance.

- e. Demand Limiting Object: Provide a demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, gas, etc.). The object shall be able to monitor a demand value and predict (using a sliding window prediction algorithm) the demand at the end of the user-defined interval period (1 to 60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user-defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment setpoints to provide the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the setpoint, display a message on the user's screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to provide both equipment protection and occupant comfort.
6. The library shall include control objects for the following functions:
 - a. Analog Input Object: Minimum requirement is to comply with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.
 - b. Analog Output Object: Minimum requirement is to comply with the BACnet standard for data sharing.
 - c. Binary Input Object: Minimum requirement is to comply with the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment runtime by counting the amount of time the hardware input is in an "on" condition. The user must be able to specify either input condition as the "on" condition.
 - d. Binary Output Object: Minimum requirement is to comply with the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as start-to-start delay must be provided. Incorporate the BACnet Command Prioritization priority scheme to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide 16 levels of priority as a minimum. Systems not employing the BACnet method of contention resolution are not acceptable.
 - e. PID Control Loop Object: Minimum requirement is to comply with the BACnet standard for data sharing. Each individual property must be adjustable to allow proportional control only, or proportional with integral control, or proportional, integral and derivative control.
 - f. Comparison Object: Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.
 - g. Math Object: Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.

- h. Custom Programming Objects: Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple BASIC-like programming language that is used to define object behavior. Provide a library of functions including, but not limited to, math and logic functions and string manipulation. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for reuse.
 - i. Interlock Object: Provide an interlock object that provides a means of coordination of objects within a piece of equipment, such as an air handler or other similar types of equipment. An example is to link the return fan to the supply fan such that, when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming, thereby eliminating nuisance alarms during the off period.
 - j. Temperature Override Object: Provide an object whose purpose is to override a binary output to an "on" state in the event a user-specified high or low limit value is exceeded. Link this object to the desired binary output object as well as to an analog object for temperature monitoring to cause the override to be enabled. This object will execute a start command at the Temperature Override level of start/stop command priority, unless changed by the user.
 - k. Composite Object: Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the "contained" application that are represented on the graphic shell of this container.
7. The object library shall include objects to support the integration of devices connected to the Network Area Controller (NAC). Provide the following as part of the standard library included with the programming software:
- a. LonMark/LonWorks Devices: These devices shall include, but not be limited to, devices for control of HVAC, lighting, access, and metering. Provide LonMark manufacturer-specific objects to facilitate simple integration of these devices. Support all network variables defined in the LonMark profile. The device manufacturer shall provide information (type and function) regarding network variables not defined in the LonMark profile.
 - b. For devices not conforming to the LonMark standard, provide a dynamic object that can be assigned to the device based on network variable information provided by the device manufacturer. Device manufacturer shall provide an XIF file, resource file, and documentation for the device to facilitate device integration.
 - c. For BACnet devices, provide the following objects:
 - 1) Analog In.
 - 2) Analog Out.
 - 3) Analog Value.

- 4) Binary.
- 5) Binary In.
- 6) Binary Out.
- 7) Binary Value.
- 8) Multi-State In.
- 9) Multi-State Out.
- 10) Multi-State Value.
- 11) Schedule Export.
- 12) Calendar Export.
- 13) Trend Export.
- 14) Device.

- d. For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.
- e. For BACnet devices, provide the following support at a minimum:

- 1) Segmentation.
- 2) Segmented Request.
- 3) Segmented Response.
- 4) Application Services.
- 5) Read Property.
- 6) Read Property Multiple.
- 7) Write Property.
- 8) Write Property Multiple.
- 9) Confirmed Event Notification.
- 10) Unconfirmed Event Notification.
- 11) Acknowledge Alarm.
- 12) Get Alarm Summary.
- 13) Who-has.
- 14) I-have.
- 15) Who-is.
- 16) I-am.
- 17) Subscribe COV.
- 18) Confirmed COV notification.
- 19) Unconfirmed COV notification.
- 20) Media Types.
- 21) Ethernet.
- 22) BACnet IP Annex J.
- 23) MSTP.
- 24) BACnet Broadcast Management Device (BBMD) function.
- 25) Routing.

2.6 TERMINAL AIR BOX (TAB) CONTROLLERS

- A. FMCS Volume Controller: Electronic, furnished and installed by TCC. Boxes shall have pressure independent control to maintain constant air volume regardless of duct pressure changes up to 6 inches w.c. and shall be accurate down to 0.004" velocity pressure. Provide velocity and static sensor at box inlet for use by unit controller. Set boxes for maximum and minimum settings shown on the drawings. Refer to Section 23 3600 for additional information.

- B. The controller shall support various digital and analog inputs and outputs as needed for damper control, control valves, electric coils, airflow sensors, remote heating, occupancy sensors, etc. and shall be capable of independent occupancy scheduling.
- C. Controller shall provide continuous zone temperature histories internal to device for up to 24 hours and perform its own limit and status monitoring and alarms to limit unnecessary communications.
- D. Operator interface to any ASC point data or programs shall be through network resident programs or portable operator's terminal connected to the specific controller.
- E. Store all system setpoints, proportional bands, control algorithms, and other programmable parameters such that a power failure of any duration does not necessitate reprogramming of the controller.
- F. BACnet TAB controllers shall either be B-AAC devices or B-ASC devices as required to meet the performance and BTL listing.

2.7 DATA COLLECTION AND STORAGE (TRENDING REQUIREMENTS)

- A. The NAC shall be able to collect data for any property of any object and store resident in the NAC that shall have, at a minimum, the following configurable properties:
 - 1. Designating the log as interval or deviation.
 - 2. For interval logs, configure the object for time of day, day of week and the sample collection interval.
 - 3. For deviation logs, configure the object for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
 - 4. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full or rollover the data on a first-in, first-out basis.
 - 5. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
- B. Store all log data in a relational database in the NAC that is accessible from a server (if the system is so configured) or a standard Web browser.
- C. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.
- D. All log data shall be available to the user in ALL the following data formats:
 - 1. HTML.
 - 2. XML.
 - 3. Plain text.
 - 4. Comma or tab separated values.
- E. The NAC shall archive its log data either locally (to itself) or remotely to a server or other NAC on the network. Provide the ability to configure the following archiving properties:

1. Archive on time of day.
2. Archive on user-defined number of data stores in the log (buffer size).
3. Archive when log has reached its user-defined capacity of data stores.
4. Provide ability to clear logs once archived.

2.8 AUDIT LOG

- A. Provide and maintain an audit log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the NAC), to another NAC on the network, or to a server. For each log entry, provide the following data:

1. Time and date.
2. User ID.
3. Change or activity: i.e., change setpoint, add or delete objects, commands, etc.

2.9 DATABASE BACKUP AND STORAGE

- A. The NAC shall automatically backup its database on a user-defined time interval.
- B. Store copies of the current database and, at the most, the recently saved database in the NAC. The age of the most recently saved database shall depend on the user-defined database save interval.
- C. Store the NAC database in XML format to allow viewing and editing. Other formats are acceptable as long as XML format is supported.

2.10 SYSTEM PROGRAMMING

- A. The GUI software shall perform system programming and graphic display engineering. Access to the GUI software shall be through password access as assigned by the system administrator.
- B. Provide a library of control, application, and graphic objects to enable creation of all applications and user interface screens. Applications shall be created by selecting the control objects from the library, dragging or pasting them on the screen, and linking them together using a built-in graphic connection tool. Completed applications may be stored in the library for future use. GUI screens shall be created in the same fashion. Data for the user displays shall be obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Provide all software tools or processes to create applications and user interface displays.
- C. Programming Methods:
1. Provide the capability to copy objects from the supplied libraries or from a user-defined library to the user's application. Link objects with a graphic linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; e.g., internal, external, hardware, etc.

2. Configuration of each object shall be done through the object's property sheet using fill-in-the-blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration is not acceptable.
3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
4. All programming shall be done in real time. Systems requiring the uploading, editing, and downloading of database objects are not allowed.
5. The system shall support object duplication in a customer's database. An application, once configured, can be copied and pasted for easy reuse and duplication. All links, other than to the hardware, shall be maintained during duplication.

2.11 DDE DEVICE INTEGRATION

- A. The NAC shall support the integration of device data via Dynamic Data Exchange (DDE) over the Ethernet network. The NAC shall act as a DDE client to another software application that functions as a DDE server.
- B. Provide the required objects in the library included with the Graphic User Interface programming software to support the integration of these devices into the FMCS. Objects provided shall include, at a minimum:
 1. DDE Generic AI Object.
 2. DDE Generic AO Object.
 3. DDE Generic BO Object.
 4. DDE Generic BI Object.

2.12 CONTROL INSTRUMENTATION

- A. Temperature Sensors:
 1. Room Temperature Sensor:
 - a. Sensor with Setpoint Adjustment and Override: Two-piece construction, ventilated plastic enclosure, off-white color, thermistor sensing element or resistance temperature device (RTD), 45°F to 90°F operating range, $\pm\pm 0.50^\circ\text{F}$ accuracy, with exposed single setpoint adjustment (no numeric temperature scale - provide with a warmer/cooler or red/blue visual scale), occupied/unoccupied override button with LED.
 2. Duct Temperature Sensor:
 - a. Thermistor or RTD type. Pneumatic transmitters with transducers are not acceptable.
- B. Humidity Measuring Devices:
 1. Humidity Sensors:

- a. Humidity Sensors: Fully electronic with no moving parts or parts requiring periodic service. Accuracy shall be minimum of 2.0 %RH accuracy from 0-90 %RH and 2.5 %RH accuracy from 90-100 %RH humidity at temperatures from 50°F to 104°F.
- b. Humidity Sensors: Fully electronic with no moving parts or parts requiring periodic service. Accuracy shall be $\pm\pm$ 2% of reading.

C. Pressure Measuring Devices

1. Differential Pressure Switches:

a. Standard Pressure Switches:

- 1) Diaphragm-activated gauge with 4-3/4" dial, cast aluminum case, sealed interior, designed to resist shock and vibration, and rated for 15 psig.
- 2) Accuracy shall be $\pm\pm$ 3% of full scale maximum throughout entire range at 70°F.
- 3) Provide mounting brackets, probes, and shutoff valves required for proper installation.
- 4) The range and service shall be as required for application or as noted on the drawings.
- 5) Provide two (2) photo-transistor-activated circuits and two (2) DPDT relays for both high or low limit alarms or controls.
- 6) Provide latching relays that require manual reset once activated.
- 7) Acceptable Manufacturer: Dwyer Photohelic Series 3000.

b. High Pressure Switches (Manual Reset):

- 1) Differential pressure switch with single pole, double-throw snap switch and enclosure.
- 2) Rated for pressure specified in sequence of control.
- 3) Electrical rating shall be 15 amps at 120-480 volts.
- 4) Setpoint adjustment shall be screw type located inside enclosure.
- 5) Provide optional manual reset for overpressure protection with all tubing, brackets, and adapters.
- 6) Repeatability: $\pm\pm$ 3%.

D. Current Measuring Devices:

1. Current Switches for Constant Speed Motors:

- a. Digital device rated for amperage load of motor or device with split core design, adjustable high and low trip points, 600 VAC rms isolation, induced power from the monitored load, LED indicator lamps for output status and sensor power. The device shall sense overloading, belt-loss, and power failure with a single signal.

2. Current Switches for Motors Controlled by VFD:

- a. Digital device rated for amperage load of motor or device with split core design, factory programmed to detect motor undercurrent conditions on variable or constant volume loads, self-calibrating, positive status indication, LED indicator lamps, 600 VAC rms isolation, induced power from the monitored load with NO output. The current sensor shall store the motor current operating parameters in non-volatile memory and have a pushbutton reset to clear the memory if the operating parameters change or the sensor is moved to another load. The device shall sense overloading, belt-loss, and power failure with a single signal. The sensor shall be mounted on the load side of variable frequency drives.

E. Occupancy Sensors:

1. Ceiling mounted, dual technology: sonic and passive infrared, 360° coverage pattern, zero crossing circuitry, adjustable sensitivity and time delay (initial setting: Time delay - 5 minutes unless noted otherwise below, integral isolated relay with normally open and normally closed outputs, LED indicator, five-year warranty, UL listed. TCC shall submit manufacturer supplied sensor layout drawing for shop drawing review. Provide full room coverage as recommended by manufacturer.
2. Space Occupancy Initial Setting Schedule
3. Initial Time
4. Space Delay Setting
5. Healthcare Procedure Room (Operating Room) 30 minutes

F. Miscellaneous Devices:

1. Control Relays:
 - a. Form "C" contacts rated for the application with "push-to-test" contact transfer feature and an integral LED to indicate coil energization.
 - b. Mount all relays and power supplies in a NEMA 1 enclosure beside the FMCS panel or controlled device and clearly label their functions.
2. Thermostat and Sensor Enclosures:
 - a. Clear plastic guard with lock. Wire guard with tamperproof screws. Setpoint shall be adjustable with cover in place. Fasten to wall separately from thermostat. Provide guards in all corridors, gymnasiums, locker rooms, toilet rooms, assembly halls and as noted on the drawings.
 - b. Heavy Duty Enclosure:
 - 1) Perforated steel, tamperproof locking thermostat and control device enclosure.
 - 2) Box shall be nominally 8"x6"x2" deep or sized as required to fit devices to be enclosed.
 - 3) Perforated cover shall be 16 gauge steel with maximum 3/16" perforations on maximum 1/4" staggered centers for a 55% free area.
 - 4) Secure to wall from inside of box. Cover shall be secured by tamperproof screws to frame.
 - 5) Color shall match electrical devices. Verify color with the Electrical Contractor.

2.13 CONDUIT AND BOXES

- A. Conduit and Boxes: Refer to Electrical Section 26 0533 for materials, sizing, and other requirements
- B. Conduit and Box Identification (Color and Labeling):
 - 1. Refer to the Temperature Control Contractor notes located on the mechanical cover sheet for raceway and box color requirements.
 - 2. Refer to Electrical Section 26 0553 for raceway and box labeling requirements.

2.14 WIRE AND CABLE

- A. Wire and Cable: Refer to Electrical Section 26 0513 for wire and cable materials.
 - 1. Wire and Cable Color: Refer to the Temperature Control Contractor notes located on the temperature controls cover sheet for wire and cable color requirements.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Verify that systems are ready to receive work. Beginning of installation means installer accepts existing conditions.
- B. Install system and materials in accordance with manufacturer's instructions.
- C. Drawings of the TCS and FMCS network are diagrammatic only. Any apparatus not shown but required to meet the intent of the project documents shall be furnished and installed without additional cost.
- D. Install all operators, sensors, and control devices where accessible for service, adjustment, calibration, and repair. Do not install devices where blocked by piping or ductwork. Devices with manual reset or limit adjustments shall be installed below 6'-0" if practical to allow inspection without using a ladder.
- E. Verify locations of wall-mounted devices (such as thermostats, temperature and humidity sensors, and other exposed sensors) with drawings and room details before installation. Coordinate mounting heights to be consistent with other wall-mounted devices. Maximum height above finished floor shall not exceed ADA mounting requirements.
- F. Provide valves over 3/4" size with position indicators and pilot positioners where sequenced with other controls.
- G. Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports. One cabinet may accommodate more than one system in same equipment room.
- H. After completion of installation, test and adjust control equipment.

- I. Check calibration of instruments. Recalibrate or replace.
 - J. Furnish and install conduit, wire, and cable per the National Electric Code, unless noted otherwise in this section.
 - K. All hardware, software, equipment, accessories, wiring (power and sensor), piping, relays, sensors, power supplies, transformers, and instrumentation required for a complete and operational FMCS system, but not shown on the electrical drawings, are the responsibility of the TCC.
 - L. Remodeling:
 - 1. All room devices as indicated on the drawings shall be removed by this Contractor. The Contractor shall also prepare the wall for finishes. Preparing the wall shall include patching old anchor holes (after the anchoring device has been removed) and sanding the wall to remove old paint outlines remaining from original devices. The wall shall be painted to match the existing wall prior to the installation of the new room device. If wall covering requires patching, the Contractor shall furnish new wall covering to match existing. If new wall covering is not available to match existing, the Contractor shall furnish a white acrylic or Plexiglas plate, 1/4" thick and sized to cover the void.
 - M. Labels For Control Devices:
 - 1. Provide labels indicating service of all control devices in panels and other locations.
 - 2. Labels may be made with permanent marking pen in the control panels if clearly legible.
 - 3. Use engraved labels for items outside panel such as outside air thermostats.
 - 4. Labels are not required for room thermostats, damper actuators and other items where their function is obvious.
- 3.2 GRAPHIC DISPLAY
- A. Create a customized graphic for each piece of equipment indicated on the itemized points list.
 - B. Components shall be arranged on graphic as installed in the field.
 - C. Include each graphic point listed in the itemized points list using real time data.
 - D. Provide a graphic representation of the following:
 - 1. Where there are multiple buildings, color code the campus map by the systems serving that building. The building graphic shall be linked to the graphic for that building's systems.
 - 2. Where there are multiple floors, provide color codes/designations for the areas served by each AHU and TAB by floor.
 - 3. Where multiple AHUs serve one floor, color code the areas served by each AHU. The area shall be linked to the graphic for that area's AHU.
 - 4. Provide an overall floor plan of each floor of the building color coded by zone linked to the TAB for that zone. The zone shall be linked to the graphic for that zone's TAB graphic.
 - 5. Show the location of each thermostat on the floor plan.

6. Provide separate graphics showing the chilled and heating water system flow diagram. Show temperatures and flows on the flow diagram. Each piece of equipment shown on the flow diagram shall be linked to the graphic for that piece of equipment.
 7. Provide a graphic showing the steam system flow diagram. Show pressures and flows on the flow diagram. Each piece of equipment shown on the flow diagram shall be linked to the graphic for that piece of equipment.
- E. The FMCS shall include full graphic operator interface to display the following graphics as a minimum:
1. Home page to include a minimum of six critical points: Outside Air Temperature, Outside Air Relative Humidity, Enthalpy, KWH, KW, etc.
 2. Graphic floor plans accurately depicting rooms, walls, hallways, and showing accurate locations of space sensors and major mechanical equipment.
 3. Detailed graphics for each mechanical system including AHUs, ERUs, EFs, chillers, and boilers, as a minimum.
 4. Access corresponding system drawings, technical literature, and sequences of operations directly from each system graphic.
- F. The FMCS shall include individual graphical buttons to access the following data stored in PDF format:
1. Project control as-built documentation including all TCS drawings, diagrams and sequences of operation.
 2. TCS Bill of Material for each system, e.g. AHU, RTU, FCU, boiler, etc.
 3. Technical literature specification data sheets for all components listed in the TCS Bill of Material.

3.3 CONDUIT AND BOXES INSTALLATION

- A. Conduit and Box Installation: Refer to Electrical Section 26 0533 for execution and installation.
- B. Conduit and Box Identification (color and labeling) installation. Refer to Electrical Section 26 0553 for raceway and box identification installation.
- C. Outlet Box Schedule: Thermostat/temperature sensor:
 1. Dry Interior Locations: Provide 4" square galvanized steel with raised cover to fit flush with finished wall line. When located in concrete block walls, provide square edge title cover of sufficient depth to extend out to face of block or masonry boxes.
 2. Other Conditions: Refer to Electrical Section 26 0533 for requirements.

3.4 WIRE AND CABLE INSTALLATION

- A. Wire and Cable Installation: Refer to Electrical Section 26 0513 for execution and installation.
- B. Field Quality Control:
 1. Inspect wire and cable for physical damage and proper connection.
 2. Torque test conductor connections and terminations to manufacturer's recommended values.

3. Perform continuity test on all conductors.
4. Protection of cable from foreign materials:
 - a. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.
 - b. Overspray of paint on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

C. Installation Schedule:

1. Conduit terminations to all devices installed in applications with rotating equipment, expansion/contraction or vibration shall be made with flexible metallic conduit, unless noted otherwise. Final terminations to exterior devices installed in damp or wet locations shall be made with liquidtight flexible metallic conduit. Terminations in hazardous areas, as defined in the National Electrical Code, shall be made with flexible conduit rated for the environment.

3.5 FMCS INSTALLATION

- A. Coordinate voltage and ampacity of all contacts, relays, and terminal connections of equipment being monitored or controlled. Voltage and ampacity shall be compatible with equipment voltage and be rated for full ampacity of wiring or overcurrent protection of circuit controlled.
- B. Naming Conventions: Coordinate all point naming conventions with Owner standards. In the absence of Owner standards, naming conventions shall use equipment designations shown on plans.

3.6 COMMISSIONING

- A. Upon completion of the installation, this Contractor shall load all system software and start up the system. This Contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to ensure that the system is functioning in full accordance with these specifications.

- B. This Contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the FMCS system operation.
- C. This Contractor shall prove that the controls network is functioning correctly and within acceptable bandwidth criteria and shall test the system with an approved protocol analysis tool. Provide a log and statistics summary showing that each channel is within acceptable parameters. Each channel shall be shown to have at least 25% spare capacity for future expansion.
- D. Upon completion of the performance tests described above, repeat these tests, point by point, as described in the validation log above in the presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.
- E. System Acceptance: Satisfactory completion is when this Contractor has performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.7 PREPARATION FOR BALANCING

- A. Verify that all dampers are in the position indicated by the controller (e.g., open, closed or modulating).
- B. Check the calibration and setpoints of all controllers.
- C. Check the locations of all thermostats and humidistats for potential erratic operation from outside influences such as sunlight, drafts, or cold walls.
- D. Check that all sequences operate as specified. Verify that no simultaneous heating and cooling occurs, unless specified. Observe that heating cannot begin at TAB reheat terminals until the unit is at the minimum cfm.
- E. Verify the operation of all interlock systems.

3.8 TEST AND BALANCE COORDINATION

- A. The Contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
- B. The Contractor shall provide a minimum of four (4) hours training for the Balancing Contractor in the use of these tools.
- C. In addition, the Contractor shall provide a qualified technician to assist in the test and balance process until the first 20 terminal units are balanced.
- D. The tools used during the test and balance process shall be returned at the completion of the testing and balancing.

3.9 DEMONSTRATION AND ACCEPTANCE

- A. At completion of installation, provide two days minimum instruction for operators. Demonstrate operation of all controls and systems. Describe the normal operation of all equipment.

3.10 TRAINING

A. On-Site:

- 1. After completion of commissioning, the manufacturer shall provide 24 hours of training on consecutive days for 12 Owner's representatives. The training course shall enable the Owner's representatives to perform Day-to-Day Operations as defined herein. A factory-trained instructor with experience in presenting the training material and the system programmer for this project shall perform the training.

B. Day-to-Day Operations - Training Description:

- 1. Proficiently operate the system.
- 2. Understand control system architecture and configuration.
- 3. Understand FMCS systems components.
- 4. Understand system operation, including FMCS system control and optimizing routines (algorithms).
- 5. Operate the workstation and peripherals.
- 6. Log-on and off the system.
- 7. Access graphics, point reports, and logs.
- 8. Adjust and change system setpoints, time schedules, and holiday schedules.
- 9. Recognize malfunctions of the system by observation of the printed copy and graphic visual signals.
- 10. Understand system drawings and Operation and Maintenance manual.
- 11. Understand the job layout and location of control components.
- 12. Access data from FMCS controllers and ASCs.
- 13. Operate portable operator's terminals.

C. Advanced Operations - Training Description:

- 1. Make and change graphics on the workstation.
- 2. Create, delete, and modify alarms, including annunciation and routing of these.
- 3. Create, delete and modify point trend logs and graph or print these both on and ad-hoc basis and at user-definable time intervals.
- 4. Create, delete, and modify reports.
- 5. Add, remove, and modify system's physical points.
- 6. Create, modify and delete programming.
- 7. Add panels when required.
- 8. Add operator interface stations.
- 9. Create, delete, and modify system displays, both graphic and others.
- 10. Perform FMCS system field checkout procedures.
- 11. Perform FMCS controller unit operation and maintenance procedures.
- 12. Perform workstation and peripheral operation and maintenance procedures.
- 13. Perform FMCS system diagnostic procedures.
- 14. Configure hardware including PC boards, switches, communication, and I/O points.

15. Maintain, calibrate, troubleshoot, diagnose, and repair hardware.
16. Adjust, calibrate, and replace system components.

D. System Management - Training Description:

1. Maintain software and prepare backups.
2. Interface with job-specific, third-party operator software.
3. Add new users and understand password security procedures.

- E. Provide course outline and materials in accordance with the "SUBMITTALS" article in Part 1 of this section. The instructor(s) shall provide one copy of training material per student.

3.11 INSTALLATION OF SENSORS

- A. Install sensors in accordance with the manufacturer's recommendations.
- B. Mount sensors rigidly and adequately for the environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
- D. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
- E. Averaging sensors and low limits shall be installed at the top of the assembly with the element on a slight downward incline away from the sensor making a serpentine pattern over the cross-sectional area with elements spaced not over 12" apart and within 6" of the top and bottom of the area.
- F. All pipe-mounted temperature sensors shall be installed in immersion wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.
- G. Install outdoor air temperature sensors on exterior of north wall, complete with sun shield at designated location approved by Architect/Engineer. TCC shall prime and paint the device enclosure. Color selection by Architect.
- H. Install all wall-mounted CO2 sensors between 3 feet and 6 feet above the floor.

END OF SECTION

SECTION 23 3100 - DUCTWORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Galvanized Ductwork
- B. Aluminum Ductwork
- C. Rectangular Ductwork
- D. Round and Flat Oval Ductwork
- E. Exposed Ductwork (Rectangular, Round, or Oval)
- F. Flexible Duct
- G. Ductwork Penetrations
- H. Painting

1.2 REFERENCES: Conform to all applicable requirements of the following publications:

- A. ADC Flexible Duct Performance and Installation Standards, 3rd Edition 1996.
- B. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. ASHRAE - Handbook 2012 Systems and Equipment; Chapter 19 - Duct Construction.
- D. ASHRAE - Handbook 2013 Fundamentals; Chapter 21 - Duct Design.
- E. ASHRAE 170 (latest published edition) - Ventilation of Health Care Facilities.
- F. ASTM A90 - Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
- G. ASTM A167- Stainless & Heat-Resisting Chromium-Nickel Steel Plate, Sheet, & Strip.
- H. ASTM A653 - Steel Sheet, Zinc-Coated (Galvanized) or zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- I. ASTM A924 - Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
- J. ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

- K. ASTM E90-02 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.
 - L. ASTM E413-87 - Classification for Rating Sound Insulation.
 - M. IECC - International Energy Conservation Code (latest published edition)
 - N. NFPA 90A - Installation of Air-Conditioning and Ventilating Systems.
 - O. NFPA 90B - Installation of Warm Air Heating and Air- Conditioning Systems.
 - P. NFPA 96 - Ventilation Control and Fire Protection of Commercial Cooking Equipment.
 - Q. SMACNA - Air Duct Leakage Test Manual.
 - R. SMACNA - HVAC Duct Construction Standards.
 - S. UL 181A - Closure Systems for Use with Rigid Air Ducts and Air Connectors
 - T. UL 181B - Closure Systems for Use with Flexible Air Ducts and Air Connectors.
- 1.3 SUBMITTALS
- A. Submit shop drawings per Section 23 0500.
 - B. Submit duct fabrication standards in compliance with SMACNA and these specifications. Clearly indicate metal gauges, reinforcement, and joining methods intended for use for each pressure classification. Furnish details of all common duct fittings and joint connections to be used on this project.
 - C. The Architect/Engineer may require field verification of sheet metal gauges and reinforcing to verify compliance with these specifications. At the request of the Architect/Engineer, the contractor shall remove a sample of the duct for verification. The contractor shall repair as needed.
 - D. Duct Layout Drawings: Submit detailed duct layout drawings at 1/4" minimum scale complete with the following information:
 - 1. Actual duct routing, ductwork fittings, actual sheet metal dimensions including insulation liner and wrap, duct hanger and support types, ductwork accessories, etc. with lengths and weights noted.
 - 2. Differentiate ducts that are wrapped. Include insulation thickness, type of insulation, and acoustical lagging.
 - 3. Room names and numbers, ceiling types, and ceiling heights.
 - 4. Indicate location of all beams, bar joists, etc. along with bottom of steel elevations for each member.

5. Verify clearances and interferences with other trades prior to preparing drawings. IMEG will provide electronic copies of ventilation drawings for contractor's use if the contractor signs and returns the "Electronic File Transfer" waiver. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for this submittal. Refer also to Section 23 0500.

- E. Duct Leakage Test Summary Report: Upon completion of the pressure test described in Part 3, the Contractor shall submit an air duct leakage test summary report as outlined in the SMACNA HVAC Duct Leakage Test Manual.

1.4 DEFINITIONS

- A. Duct Sizes shown on drawings are inside clear dimensions. Maintain clear dimensions inside any lining.
- B. Transitions are generally not shown in single-line ductwork. Where sizes change at a divided flow fitting, the larger size shall continue through the fitting.
- C. Exterior Duct: Ductwork located outside the conditioned envelope including exposed ductwork above the roof, outside exterior walls, in attics above insulated ceilings, inside parking garages, and crawl spaces.
- D. Interior Duct: Ductwork located within the conditioned envelope including return air plenums and indirectly conditioned spaces.

1.5 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 23 0500 for required duct systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.
- B. Duct drawings shall be at 1/4" minimum scale complete with the following information:
 1. Actual duct routing, ductwork fittings, actual sheet metal dimensions including insulation liner and wrap, duct hanger and support types, ductwork accessories, etc. with lengths and weights noted.
 2. Differentiate ducts that are lined or wrapped. Include insulation thickness, type of insulation, and acoustical lagging.
 3. Location and size of all duct access doors.
 4. Room names and numbers, ceiling types, and ceiling heights.
 5. Indicate location of all beams, bar joists, etc. along with bottom of steel elevations for each member.
 6. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings. Architectural plans will need to be obtained from the Architect.

PART 2 - PRODUCTS

2.1 SHAPE

A. Rectangular Duct - Single Wall:

1. General Requirements:

- a. All ductwork gauges and reinforcements shall be as listed in SMACNA Duct Construction Standards Chapter 2. Where necessary to fit in confined spaces, furnish heaviest duct gauge and least space consuming reinforcement.
- b. Transitions shall not exceed the angles in Figure 4-7.

2. Exceptions and modifications to the 2005 HVAC Duct Construction Standards are:

- a. All ducts shall be cross-broken or beaded.
- b. Snap lock seams are not permitted.
- c. Turning vanes shall be used in all 90° mitered elbows, unless clearly noted otherwise on the drawings. Vanes shall be as follows:

1) Type 1:

- a) Description: Single wall type with 22-gauge (0.029") or heavier vanes, 3-1/4" blade spacing, and 4" to 4-1/2" radius. Vanes hemmed if recommended by runner manufacturer. Runners shall have extra-long locking tabs. C-value independently tested at below 0.26. EZ Rail II by Sheet Metal Connectors or equal.
- b) Usage: Limited to 3,000 fpm and vane lengths 36" and under.

2) Turning vanes shall operate quietly. Repair or replace vanes that rattle or flutter.

3) Runners must be installed at a 45° angle. Elbows with different size inlet and outlet must be radius type.

4) Omitting every other vane is prohibited.

- d. Where smooth radius rectangular elbows are shown, they shall be constructed per SMACNA Figure 4-2. Type RE1 shall be constructed with a centerline duct radius R/W of 1.0. Where shown on drawings, Type RE3 elbows with 3 vanes shall be used with centerline duct radius R/W of 0.6 (SMACNA r/W=0.1). RE1 or RE3 elbows may be used where mitered elbows are shown if space permits. Mitered elbows (with or without turning vanes) may not be substituted for radius elbows. Do not make branch takeoffs within 4 duct diameters on the side of the duct downstream from the inside radius of radius elbows.
- e. Rectangular branch and tee connections in ducts over 1" pressure class shall be 45° entry type per Figs. 4-5 and 4-6. Rectangular straight taps are not acceptable above 1" pressure class.
- f. Bellmouth fittings shown on return duct inlets shall expand at a 60-degree total angle horizontally and vertically (space permitting) and have length of at least 25% of the smallest duct dimension.

- g. Round taps off rectangular unlined ducts shall be flanged conical or bellmouth type (equal to Buckley Bellmouth or Sheet Metal Connectors E-Z Tap), or 45° rectangular with transition to round (equal to Sheet Metal Connectors Inc. High Efficiency Takeoff). Straight taps are acceptable if pressure class is 1" or less, round duct is 12" diameter or less, and the tap is not located between fans and TAB devices.
- h. Duct offsets shall be constructed as shown on drawings. Additional offsets required in the field shall be formed of mitered elbows without turning vanes for offsets up to 30° maximum angle in accordance with SMACNA offset Type 2. Offsets of greater than 30° angle shall be formed of radius elbows with centerline radius R/W=1.0 or greater. SMACNA Type 1 offsets are not permitted.
- i. All lined duct shall utilize dovetail joints where round or conical taps occur. The dovetail joints shall extend past the liner before being folded over.
- j. Cushion heads are acceptable only downstream of TAB devices in ducts up to ± 2" pressure class, and must be less than 6" in length.
- k. Slide-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.
 - 1) Apply sealant to all inside corners. Holes at corners are not acceptable.
 - 2) Manufacturers:
 - a) Ductmate Industries - 25/35/45
 - b) Nexus
 - c) Mez
 - d) WDCI
 - e) Other manufacturers must submit test data and fabrication standards and receive Architect/Engineer's approval before any fabrication begins.
- l. Formed-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.
 - 1) Apply sealant to all inside corners. Holes at corners are not acceptable.
 - 2) Flanges shall be 24-gauge minimum (not 26 gauge).
 - 3) Manufacturers:
 - a) Lockformer TDC
 - b) TDF
 - c) United McGill
 - d) Sheet Metal Connectors
 - e) Other manufacturers must submit test data and fabrication standards and receive Architect/Engineer's approval before any fabrication begins.

B. Round and Flat Oval Spiral Seam Ductwork - Single Wall:

1. Conform to applicable portions of Rectangular Duct Section. Round or flat oval ductwork may be substituted for rectangular ductwork where approved by the Architect/Engineer. The spiral seam ductwork shall meet the standards set forth in this specification. The ductwork shall meet or exceed the specified cross-sectional area and insulation requirements. The substitution shall be coordinated with all other trades prior to installation.
2. Flat oval duct in negative pressure applications shall have flat sides reinforced as required for rectangular ducts of the same gauge with dimensions equal to the flat span of the oval duct.
3. 90° elbows shall be smooth radius or have a minimum of five sections with mitered joints and R/D of at least 1.5.
4. Duct and fittings shall meet the required minimum gauges listed in chapter 3 of the SMACNA requirements for the specified pressure class. Ribbed and lightweight duct are not permitted.
5. Ductwork shall be suitable for velocities up to 5,000 fpm.
6. Divided flow fittings may be made as separate fittings or factory installed taps with sound, airtight, continuous welds at intersection of fitting body and tap.
7. Spot weld and bond all fitting seams in the pressure shell. Coat galvanizing damaged by welding with corrosion resistant paint to match galvanized duct color.
8. Ducts with minor axis less than 22" shall be spiral seam type. Larger ducts may be rolled, longitudinal welded seam type. SMACNA seams RL-2 and RL-3 are not permitted.
9. Reinforce flat oval ducts with external angles. Internal tie rods are permitted only as indicated for rectangular ductwork.
10. Transverse Joint Connections:
 - a. Crimped joints are not permitted.
 - b. Ducts and fittings 36" in diameter and smaller shall have slip joint connections. Size fitting ends to slip inside mating duct sections with minimum 2-inch insertion length and a stop bead. Use inside slip couplings for duct-to-duct joints, and outside slip couplings for fitting-to-fitting joints.
 - c. Ducts and fittings larger than 36" shall have flanged connections.
 - d. Secure all joints with at least 3 sheet metal screws before sealing.
 - e. Manufacturers:
 - 1) Slide-on Flanges:
 - 2) Ductmate Industries - SpiralMate
 - 3) Accuflange
 - 4) Sheet Metal Connectors are acceptable.
 - f. Manufacturers, Self-Sealing Duct Systems:
 - 1) Lindab
 - 2) Ward "Keating Coupling"

2.2 MATERIAL AND APPLICATION SPECIFIC

A. Galvanized Steel:

1. General Requirements:
 - a. Duct and reinforcement materials shall conform to ASTM A653 and A924.

- b. Interior Ductwork and reinforcements: G60 galvanized (0.60 ounces per square foot total zinc coating for two sides per ASTM A90) unless noted otherwise.
 - c. Exterior Ductwork: G90 galvanized (0.90 ounces per square foot total zinc coating for two sides per ASTM A90) unless noted otherwise. G60 is not acceptable for exterior use.
 - d. Ductwork reinforcement shall be of galvanized steel.
2. Duct Hangers and Support:
- a. Ductwork supports shall be of galvanized or painted steel.
 - b. All fasteners shall be galvanized or cadmium plated.
 - c. Strap Hangers: Strap hanger shall be a minimum of 1 inch, 18 gauge galvanized steel attached to the bottom of ducts with spacing as required by SMACNA.
 - d. Cable Hangers:
 - 1) Aircraft cable and slip cable hangers are acceptable for ducts up to 18" diameter. Protective sleeve tubing shall be used on the cable when supporting duct with exterior insulation. Corner saddles are required when supporting rectangular ductwork. Manufacturers; Supports:
 - a) Gripple
 - b) Ductmate
 - c) Duro Dyne
 - d) Architect/Engineer approved
 - e. Integral Corner Connector Hanger: Integral hanger and corner assembly for use with TDC/TDF style duct flanges. Die stamped offset hanger connects to the flanged corner assembly. For use with aircraft cable or 1/4" or 3/8" diameter threaded rods. Tested to hold up to 1,400 lbs.. Install per manufacturerTMs ratings and instructions.
 - 1) Manufacturers; Supports:
 - a) EZ Hanger
- B. Aluminum Ductwork:
- 1. General Requirements:
 - a. Material: ASTM B209; aluminum sheet, Alloy 3003-H14. Aluminum connectors and bar stock: Alloy 6061-T6. Aluminum or stainless steel fasteners are acceptable.
 - b. All duct gauges and reinforcement shall be as called for in Tables 2-50, 2-51, 2-52, and 3-14 of the SMACNA HVAC Duct Construction Standards.
 - c. Ductwork reinforcement shall be of aluminum.
 - 2. Duct Hangers and Supports:
 - a. Ductwork supports shall be of aluminum, galvanized steel or painted steel. Slip cable hangers are acceptable.
 - 1) Manufacturers, Supports:

- a) Gripple
 - b) Ductmate
 - c) Duro Dyne
 - d) Architect/Engineer approved
- b. All other requirements are as noted for galvanized rectangular sheet metal duct.
- C. Exposed Ductwork (Rectangular, Round, and Flat Oval):
1. The following applies to all ductwork exposed in finished areas in addition to requirements noted above:
 - a. Provide extra shipping protection. Use Cardboard or other protective means to prevent dents and deformed ends.
 - b. Provide cardboard or other means of protection during field fabrication. Protect from scratches. Provide stiffeners to retain shape during fabrication.
 - c. Remove all identification stickers and thoroughly clean exterior of all ducts.
 - d. Locate fitting seams on least visible side of duct.
 - e. Provide exterior finish suitable for field painting without further oil removal.
 - f. Provide ramp-type internal joint couplings. Provide bead of sealant around the inside of the duct about 1/2" from the end of the duct.
 - g. Manufacturers, Slide-on Flanges:
 - 1) Ductmate Industries
 - 2) Accuflange
 - 3) Sheet Metal Connectors
 - h. Manufacturers, Self-Sealing Duct System:
 - 1) Lindab
 - 2) Ward "Keating Koupling"
 - i. The system shall be free of visible dents and scratches when viewed from normal occupancy.
 - j. All insulation shall be internal, except at reheat coils.
 2. In addition to the paragraphs above, this section applies to all ductwork specified or shown as "Architecturally Exposed":
 - a. All spiral ductwork fittings shall be carbon arc welded.
 - b. Grind all welds to remove irregularities.
 - c. Conical taps shall be one piece. Taps for grilles and takeoffs shall be factory installed with a continuous weld and ground smooth.
 - d. Welds shall be ground smooth and painted.
 - e. All architecturally exposed ducts shall be round or flat oval except where not possible (grilles, reheat coils, etc.).
 3. Alternate manufacturers, including shop fabricated duct, must be reviewed before installation. The following information is required:

- a. Metal gauge of duct and fittings.
 - b. Fitting type and construction.
 - c. Type and size of reinforcement.
4. Hangers for Exposed Ductwork:
- a. Round Ducts:
 - 1) Threaded rod with duct fixing bracket and metal strap. Provide single threaded rod centered on the duct. Strap hanger shall be a minimum of 1 inch, 18 gauge galvanized steel wrapping the circumference of the duct. Spacing as required by SMACNA guidelines.
 - 2) Aircraft cable and slip cable hangers are acceptable for ducts up to 18" diameter. Protective sleeve tubing shall be used on the cable when supporting duct with exterior insulation. Spacing and cable size as required by SMACNA guidelines.
 - a) Manufacturers, Supports: Gripple, Ductmate, Duro Dyne, Architect/Engineer approved.
 - b. Rectangular Ducts:
 - 1) Aircraft cable and slip cable hangers are acceptable for ducts up to 18" in maximum dimension. Protective sleeve tubing shall be used on the cable when supporting duct with exterior insulation. Corner saddles are required when supporting rectangular ductwork. Spacing and cable size as required by SMACNA guidelines.
 - a) Manufacturers, Supports: Gripple, Ductmate, Duro Dyne, Architect/Engineer approved.
 - c. Strut-channel and all-thread rod is not acceptable for exposed ductwork.
 - d. All fasteners shall be galvanized or cadmium plated.

2.3 DUCTWORK REINFORCEMENT

- A. All reinforcement shall be external to the duct except that tie rods may be used with the following limitations.
1. Ducts must be over 18" wide.
 2. Duct dimensions must be increased 2" in one dimension (h or w) for each row of tie rods installed.
 3. Tie rods must not exceed 1/2" diameter.
 4. Manufacturer of tie rod system must certify pressure classifications of various arrangements, and this must be in the shop drawings.

2.4 DUCTWORK SEALANTS

- A. One-part joint sealers shall be water-based mastic systems that meet the following requirements: maximum 48-hour cure time, service temperature of -20°F to +175°F, resistant to mold, mildew and water, flame spread rating below 25 and smoke-developed rating below 50 when tested in accordance with ASTM E84, suitable for all SMACNA seal classes and pressure classes. Mastic used to seal flexible ductwork shall be marked UL 181B-M. Joint sealers for use on exterior weather exposed ductwork shall be rated for -30°F to +175°F and 2000-hour minimum UV resistance per ASTM G-53.
- B. Adhesives and Sealants: All sealers, adhesives, and sealants shall comply with the low emitting material limits of the following standards:
 - 1. LEED v4 - Low Emitting Materials - Adhesives and Sealants.
- C. Where pressure sensitive tape is called for on drawings and specifications for sealing flexible ductwork, tape shall be minimum 2.5-inch wide, UL 181 B-FX listed, and marked tape having minimum 60 oz/inch peel adhesion to steel and service temperature range from -20°F to +250°F.
 - 1. Manufacturers, Pressure-Sensitive Tape:
 - a. Venture Tape 1581A
 - b. Compac #340
 - c. Scotch Foil Tape 3326
 - d. Polyken 339

2.5 FLEXIBLE DUCT

- A. Flexible duct shall be listed and labeled as UL 181 Class 1 Air Duct Material, and shall comply with NFPA 90A and 90B, and meet GSA, FHA and other U.S. Government agency standards. Flexible duct shall bear the ADC Seal of Certification.
- B. Flame Spread/Smoke Developed: Not over 25/50.
- C. Stretch all flexible duct to prevent sags and reduce air friction. Shorten and reinstall all sagging or loose flexible duct. Avoid sharp elbows. Elbows shall maintain 1.5 diameter centerline turning radius.
- D. Install per the SMACNA Flexible Duct Manual. Secure inner layer with draw band. Wrap with pressure sensitive tape for protection prior to installing draw band. Pressure sensitive tape alone is not acceptable.
- E. Standard:
 - 1. Flexible duct shall have corrosion-resistant wire helix, bonded to an inner liner that prevents air from contacting the insulation, covered with minimum 1-1/2", 3/4 lb/cf density fiberglass insulation blanket, sheathed in a vapor barrier of metalized polyester film laminated to glass mesh. Usage: All areas unless noted otherwise.

2. Inner liner shall be airtight and suitable for 6" WC static pressure through 16" diameter. Outer jacket shall act as a vapor barrier only with permeance not over 0.1 perm per ASTM E96, Procedure A. "R" value shall not be less than 4.0 ft²*°F*hr/Btuh. Temperature range of at least 0-180°F. Maximum velocity of 4,000 fpm.
 3. Usage:
 - a. Take-offs from supply ducts to inlets of terminal air boxes. Do not exceed 36" in length.
 - b. Connections to air inlets and outlets. Do not exceed 5'-0" in length.
- F. Radius Forming Elbows:
1. Flexible plastic radius forming elbow for use with flexible ducts to create 90deg elbow. One size for 6" to 16" diameter ducts. UL listed for return plenum spaces.
 2. Usage: All supply air terminals with flexible ductwork connection.
 3. Installation: Attach to flex duct and secure draw bands without crushing flex duct to form smooth radius elbow. Suspend radius forming elbow to structure. Install per manufacturerTM instructions.
 4. Acceptable Manufacturers:
 - a. Hart & Cooley - Smartflow
 - b. Thermaflex - Flexflow
 - c. Titus - Flexright

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide openings in ducts for thermometers and controllers.
- B. Locate ducts with space around equipment for normal operation and maintenance.
- C. Do not install ducts or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the electrical equipment. Unless intended to serve these rooms, do not install any ductwork or equipment in electrical rooms, transformer rooms, electrical closets, telephone rooms or elevator machine rooms.
- D. Provide temporary closures of metal or taped polyethylene on open ducts to prevent dust from entering ductwork.
- E. Supply ductwork shall be free of construction debris, and shall comply with Level "C" of the SMACNA Duct Cleanliness for New Construction Guidelines.
- F. Repair all duct insulation and liner tears.

- G. Install manual volume dampers in branch supply ducts so all outlets can be adjusted. Do not install dampers at air terminal device or in outlets, unless specifically shown.
- H. Insulate terminal air box reheat coils. Seal insulation tight to form a tight vapor barrier.
- I. Install flexible duct in accordance with the ADC Flexible Duct Performance and Installation Standards.
- J. Flexible duct shall NOT be joined to flat-oval connections. Provide sheet metal oval-to-round transitions where required, to include, but not limited to, all connections to air inlets, air outlets, and terminal air boxes.
- K. Adhesives, sealants, tapes, vapor retarders, films, and other supplementary materials added to ducts, plenums, housing panels, silencers, etc. shall have flame spread/smoke developed ratings of under 25/50 per ASTM E84, NFPA 255, or UL 723.
- L. All duct support shall extend directly to building structure. Do not support ductwork from pipe hangers unless coordinated with piping contractor prior to installation. Do not allow lighting or ceiling supports to be hung from ductwork or ductwork supports.

3.2 DUCTWORK APPLICATION SCHEDULE

A. General:

- 1. Seal Class is per SMACNA HVAC Air Duct Leakage Test Manual
- 2. Insulation:
 - a. Refer to Section 23 0713 for insulation types.
 - b. Type A insulation (Flexible Fiberglass Wrap) R-values noted are based on installed values (25% compression).
- 3. Note 1: Apply aluminum based adhesive sealant tape at non-flanged joints on ducts serving dedicated outside air supply (DOAS) and exhaust system in addition to Class A sealant.
- 4. Note 2: Apply aluminum based adhesive sealant tape on TAB boxes (all seams and joints of the box and duct connections) serving dedicated outside air supply (DOAS) system.

B. Supply Duct from Fan to Terminal Air Boxes - Single Wall:

- 1. Shape:
 - a. Rectangular Duct - Single Wall
 - b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
- 2. Material: Galvanized Steel
- 3. Pressure Class: +3"
- 4. Seal Class: A
- 5. Insulation:
 - a. IECC-2021: 1-1/2" thick Type A (R=4.5)

6. Additional Requirements: None
- C. Supply Duct from Terminal Air Boxes to Outlets - Exposed in Dog Kennel Area :
1. Shape:
 - a. Rectangular Duct - Single Wall
 - b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
 2. Material: Aluminum
 3. Pressure Class: +2"
 4. Seal Class: A
 5. Insulation:
 - a. IECC-2021:1-1/2" thick Type A (R=4.5)
 6. Additional Requirements: None.
- D. Supply Duct from Terminal Air Boxes to Outlets:
1. Shape:
 - a. Rectangular Duct - Single Wall
 - b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
 2. Material: Galvanized Steel
 3. Pressure Class: +2"
 4. Seal Class: A
 5. Insulation:
 - a. IECC-2021: 1-1/2" thick Type A (R=4.5)
 6. Additional Requirements: None
- E. Return Duct:
1. Shape:
 - a. Rectangular Duct - Single Wall
 - b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
 2. Material: Galvanized Steel
 3. Pressure Class: -2"
 4. Seal Class: A
 5. Insulation:
 - a. IECC-2021: 1" thick Type C (R=3.6)
 6. Additional Requirements: None

F. General Exhaust Duct - Exposed in Kennel Room:

1. Shape:
 - a. Rectangular Duct - Single Wall
 - b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
2. Material: Aluminum
3. Pressure Class: -1"
4. Seal Class: A
5. Insulation:
 - a. None
6. Additional Requirements: None

G. General Exhaust Duct:

1. Shape:
 - a. Rectangular Duct - Single Wall
 - b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
2. Material: Galvanized Steel
3. Pressure Class: -1"
4. Seal Class: A
5. Insulation: None
6. Additional Requirements: None

H. All Terminal Air Box/ Reheat Coil Headers and Duct Mounted Coil Headers:

1. Insulation: 1-1/2" thick Type A (R=4.5)

I. Linear Diffuser Supply Plenum:

1. Insulation:
 - a. IECC-2021: 1/2" thick Type C (R=1.8)

3.3 DUCTWORK SEALING

A. General Requirements:

1. Openings, such as rotating shafts, shall be sealed with bushings or similar.
2. Pressure sensitive tape shall not be used as the primary sealant unless it has been certified to comply with UL-181A or UL-181B by an independent testing laboratory and the tape is used in accordance with that certification.
3. All connections shall be sealed including, but not limited to, taps, other branch connections, access doors, access panels, and duct connections to equipment. Sealing that would void product listings is not required. Spiral lock seams need not be sealed.

4. Mastic-based duct sealants shall be applied to joints and seams in minimum 3 inch wide by 20 mil thick bands using brush, putty knife, trowel, or spray, unless manufacturer's data sheet specifies other application methods or requirements.
- B. All ducts systems, regardless of pressure class, shall be Seal Class A as defined by Section 5-1 of SMACNA HVAC Air Duct Leakage Test Manual per the Energy Code, unless specifically noted otherwise. Seal Class A shall include sealing of all transverse joints, longitudinal seams, and duct wall penetrations with welds, gaskets, mastics, or fabric-embedded mastic system. Joints are inclusive of, but not limited to, girth joints, branch and sub-branch intersections, duct collar tap-ins, fitting subsections, louver and air terminal connections to ducts, access door and access panel frames and jambs, duct, plenum, and casing abutments to building structures.
- C. Double-wall ductwork: Install insulation end fittings at all transitions from double to single-wall construction.

3.4 TESTING

- A. Interior Duct - Less than 3" WG (positive or negative):
 1. Leak testing of these pressure classes is not normally required for interior ductwork (inside the building envelope). However, leak tests will be required if, in the opinion of the Architect/Engineer, the leakage appears excessive. All exterior ductwork shall be tested. If duct has outside wrap, testing shall be done before it is applied.
 2. Leak test shall be at the Contractor's expense and shall require capping and sealing all openings.
 3. Seal ducts to bring the air leakage into compliance.
 4. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing.
- B. Interior Duct - 3" WG and Above (positive or negative):
 1. A minimum of 25% of interior ductwork (inside the building envelope) shall be tested. The Owner or designated representative shall select the sections to be tested. If duct has outside wrap, testing shall be done before it is applied.
 2. Duct system shall be completely pressure tested. If duct has outside wrap, testing shall be done before it is applied.
 3. Leak test shall be at the Contractor's expense and shall require capping and sealing all openings.
 4. Seal ducts to bring the air leakage into compliance.
 5. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing.
- C. Test Procedure:
 1. Testing shall be as listed in the latest edition of the SMACNA HVAC Duct Leakage Manual, with the following additional requirements:
 - a. The required leakage class for Seal Class A, rectangular ducts, shall be 4; round shall be 2.

- b. Test pressure shall be the specified duct pressure class. Testing at reduced pressures and converting the results mathematically is not acceptable. This is required to test the structural integrity of the duct system.
- c. If any leak causes discernible noise at a distance of 3 feet, that leak shall be eliminated, regardless of whether that section of duct passed the leakage test.
- d. All joints shall be felt by hand, and all discernible leaks shall be sealed.
- e. Totaling leakage from several tested sections and comparing them to the allowable leakage for the entire system is not acceptable. Each section must pass the test individually.
- f. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing. Failure to notify the Architect/Engineer of pressure testing may require the contractor to repeat the duct pressure test after proper notification.
- g. Upon completion of the pressure test, the contractor shall submit an air duct leakage test summary report as outlined in the SMACNA HVAC Duct Leakage Test Manual.
- h. All access doors, taps to terminal air boxes, and other accessories and penetrations must be installed prior to testing. Including terminal air boxes in the test is not required.
- i. Positive pressure leakage testing is acceptable for negative pressure ductwork.

3.5 DUCTWORK PENETRATIONS

- A. All duct penetrations of firewalls shall have fire or fire/smoke dampers where required by code.
- B. Dampers shall be compatible with fire rating of wall assembly. Verify actual rating of any wall being penetrated with Architect/Engineer.
- C. Seal all duct penetrations of walls that are not fire rated by caulking or packing with fiberglass. Install trim strip to cover vacant space and raw construction edges of all openings in finished rooms. Install escutcheon ring at all round duct openings in finished rooms. Trim strips and rings shall be same material and finish as exposed duct.

3.6 PAINTING

- A. Paint interior of ducts color of architect's choice within twice the largest duct dimension of inlets and outlets where interior of duct is visible.
- B. Paint bottom of ducts color of architect's choice within twice the largest duct dimension where a duct is routed above an unducted perforated grille and the duct is visible.

END OF SECTION

SECTION 23 3300 - DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Manual Volume Dampers.

1.2 REFERENCES

- A. ASTM E477-06a - Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
- B. NFPA 90A - Installation of Air-Conditioning and Ventilating Systems.
- C. SMACNA - HVAC Duct Construction Standards - Third Edition - 2005.

PART 2 - PRODUCTS

2.1 MANUAL VOLUME DAMPERS

- A. Fabricate in accordance with SMACNA Duct Construction Standards, and as indicated.
- B. Fabricate single blade dampers for duct sizes to 9-1/2 x 30 inches.
- C. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 12" x 72". Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
- D. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide molded synthetic or oil-impregnated nylon or sintered bronze bearings.
- E. Provide locking quadrant regulators on single and multi-blade dampers.
- F. On insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
- G. If blades are in open position and extend into the main duct, mount damper so blades are parallel to airflow.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General Installation Requirements:
 - 1. Install accessories in accordance with manufacturer's instructions.

2. Where duct access doors are located above inaccessible ceilings, provide ceiling access doors. Coordinate location with the Architect/Engineer.
3. Coordinate and install access doors provided by others.
4. Provide access doors for all equipment requiring maintenance or adjustment above an inaccessible ceiling. Minimum size shall be 24" x 24".
5. Provide duct test holes where indicated and as required for testing and balancing purposes.

B. Manual Volume Damper:

1. Provide manual volume dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts where indicated on drawings and as required for air balancing. Use splitter dampers only where indicated.
2. Provide ceiling access doors for manual volume dampers. When manual volume dampers are located above an inaccessible ceiling and an access door cannot be installed, provide a remote-controlled volume control device for operation of the damper. Coordinate location with the Architect/Engineer.

END OF SECTION

SECTION 23 3423 - POWER VENTILATORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Roof Exhaust Fan.
- B. Rooftop Fan Curbs.

1.2 QUALITY ASSURANCE

- A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300.
- C. Fabrication: Conform to AMCA 99.
- D. Fan Energy Index (FEI): Fans shall meet or exceed the minimum FEI scheduled at the specified airflow, pressure, and air density (duty point). In no case shall the FEI at the specified duty point fall below 1.0.

1.3 REFERENCES

- A. AMCA 99 - Standards Handbook.
- B. AMCA 208 - Calculation of the Fan Energy Index (FEI).
- C. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.
- D. AMCA 230 - AMCA 230 - Laboratory Methods of Testing Air Circulating Fans for Rating and Certification.
- E. AMCA 300 - Test Code for Sound Rating Air Moving Devices.
- F. AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices.
- G. ANSI/AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- H. ANSI/AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- I. SMACNA - HVAC Duct Construction Standards, 1995 Edition.

1.4 SUBMITTALS

- A. Submit shop drawings per Section 23 0500. Include data on all fans and accessories. Submit sound power levels for both fan inlet and outlet at rated capacity. Submit motor ratings and electrical characteristics, plus motor and electrical accessories. Submit multi-speed fan curves including minimum and maximum fan speed with specified operating points clearly plotted. Submit the Fan Energy Index (FEI) at the selected duty point (ceiling and HVLS fans are exempt from FEI submittal requirements).
- B. Submit manufacturer's installation instructions.
- C. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

1.5 EXTRA STOCK

- A. Provide one (1) extra belt set for each fan unit.

PART 2 - PRODUCTS

2.1 ROOFTOP EXHAUST FAN - DIRECT DRIVEN

- A. Fan Wheel: Centrifugal type, aluminum or composite with backward inclined or airfoil blades, statically and dynamically balanced.
- B. Housing: Removable, spun aluminum dome or rectangular top, with square, one piece, aluminum base and curb cap with Venturi inlet cone.
- C. Fan Shaft: Turned, ground and polished steel; keyed to wheel hub.
- D. All steel parts galvanized or epoxy coated. Non-corrosive fasteners.
- E. Direct drive, motor mounted outside of air stream and ventilated with outside air.
- F. Aluminum or brass bird screen. Plastic mesh will not be allowed.
- G. Furnish factory mounted and wired disconnect switch: Non-fusible type with thermal overload protection mounted inside fan housing, factory wired through an aluminum conduit.
- H. Disconnect provided by Electrical Contractor.
- I. Furnish solid-state dial speed controller. Mount and wire inside fan unless shown otherwise on the drawings. Provide permanent marking at balanced point.
- J. Furnish normally closed, electric motorized damper. Provide step-down transformer if required. Install and wire damper to open when fan runs.
- K. Dampers shall be aluminum with brass bushings, blade seals and blade tie rods. Leakage shall not exceed 4 cfm/sq.ft @1" SP (or shall be AMCA Class 1 certified).

- L. Mill aluminum finish.
- M. Furnish permanently lubricated sealed ball type motor and drive shaft bearings. Motor and wheel supported by vibration isolators.
- N. Manufacturers:
 - 1. Aerovent "FACX"
 - 2. Cook "ACE-D"
 - 3. Greenheck
 - 4. ILG - CRD
 - 5. ACME PX
 - 6. PennBarry DX
 - 7. Carnes
 - 8. Twin City DCRU
 - 9. Jenco
 - 10. Soler-Palau
 - 11. York

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure roof exhausters with cadmium plated lag screws to roof curb.
- C. If manufacturer has no recommendations, secure roof exhaust fans to curbs with 1/4" lag bolts on 8" maximum centers.
- D. MC shall install and wire factory provided damper to open when the fan runs if the manufacturer does not provide an option to pre-wire the damper.

END OF SECTION

SECTION 23 3600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Single Duct Variable Air Volume Terminal Box.

1.2 REFERENCES

- A. NFPA 70 - National Electrical Code.
- B. NFPA 90A - Installation of Air-Conditioning and Ventilation Systems.
- C. UL 181 - Factory-Made Air Ducts and Connectors.

1.3 SUBMITTALS

- A. Submit shop drawings under provisions of Section 23 0500.
- B. Submit shop drawings indicating configuration, general assembly, and materials used in fabrication.
- C. Submit product data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings which indicate airflow, static pressure, and NC designation.
- D. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of one to 4 inch WG.
- E. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
- F. Submit manufacturer's installation instructions.

1.4 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data.
- B. Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists.
- C. Include directions for resetting constant volume regulators.

PART 2 - PRODUCTS

2.1 ACOUSTICAL CONSIDERATIONS (THIS APPLIES TO ALL UNITS)

- A. All units shall have noise data certified in accordance with AHRI Standard 885-98 with 5/8" 20-lb. density mineral fiber ceiling tile and shall not produce space noise values over NC-35 due to radiated and airborne noise combined. Acoustical considerations shall take priority over sizes noted in schedule. It is the manufacturer's responsibility to increase inlet size to meet acoustic levels scheduled.

2.2 SINGLE DUCT VARIABLE AIR VOLUME TERMINAL BOX

- A. Casing: Minimum 22 gauge galvanized steel.
 - 1. Fully insulated with minimum 1" foil faced liner, minimum 1-1/2 pound density fiberglass insulation. Insulation shall be UL listed and meet NFPA 90A requirements.
 - a. Usage: All supply air systems.
- B. Damper Blade: Extruded aluminum or minimum 18 gauge galvanized steel. Nylon or bronze bushings on damper shafts. Dampers shall seal against gasketed stops. Leakage shall not exceed 4% of unit nominal cfm at 3.0 inches WG inlet static pressure.
- C. Inlet Flow Sensor: Provide "cross" □□ or "ring□□" style velocity and static sensor at inlet to box for use by unit controller.
- D. Damper Operators: Electronic. Furnish all mounting brackets, relays, and linkages. Provided and installed by the manufacturer.
 - 1. Operator shall be UL listed, electronic direct coupled with spring return to normal position for modulating or two-position control as noted in the sequence of control. Actuator shall be 24 VAC with proportional control, electronic overload protection to prevent actuator damage due to over-rotation and "V" bolt clamp with matching "V" toothed cradle (single bolt or setscrew fasteners not acceptable).
- E. Electronic Volume Regulator/Controller: Provided and installed by the manufacturer. Boxes shall have pressure independent control to maintain constant air volume regardless of duct pressure changes up to 6 inches w.c. and shall be accurate down to 0.004" velocity pressure. Set boxes for maximum and minimum settings shown on the drawings.
- F. Electric Heating Coil: Open nichrome type electric resistance coils, automatic reset thermal cutout primary safety device, manual reset thermal cutout secondary safety device, airflow switch interlock, disconnect switch on face of integral control panel, magnetic contactors, 24-volt control, control voltage transformer and fusing, pressure-electric switch for - - multi-stage step SCR control. Capacity and voltage shall be as scheduled on the drawings.
- G. Boxes shall not exceed the static pressure drop and N.C. level scheduled on the drawings. It is the manufacturer's responsibility to increase inlet size to meet pressure drop and N.C. levels scheduled.

H. Refer to control diagrams and notes on control drawings for complete sequence of control.

I. Manufacturers:

1. Carrier
2. Titus
3. Trane
4. Krueger
5. Carnes
6. E.H. Price
7. Tuttle & Bailey
8. Nailor
9. Enviro-Tec
10. Metalaire.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Maintain minimum working clear space for all electrical connections in accordance with NFPA 70, National Electrical Code.
- C. Provide ceiling access doors or locate units above easily removable ceiling components.
- D. Support units individually from structure. Do not support from adjacent ductwork.
- E. Where boxes are located adjacent to a wall or joist, the damper motors and control valves shall be located on the side of the box away from the wall or joist to permit easy access.
- F. Comb fins on coils to repair bent fins.
- G. Insulate terminal air box hydronic reheat coils to prevent condensation. Tape insulation tight to box. Do not insulate or interfere with actuator, access panel and control panel.

3.2 ADJUSTING

- A. All boxes shall be set to the cfm shown on the drawings. TCC shall be responsible to field recalibrate all boxes that are not set correctly.

END OF SECTION

SECTION 23 3700 - AIR INLETS AND OUTLETS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Grilles And Registers.
- B. Architectural Square Panel Diffusers.
- C. Linear Diffusers.
- D. Linear Diffuser Supply Plenum.

1.2 QUALITY ASSURANCE

- A. Test and rate performance of air inlets and outlets per ASHRAE 70.
- B. Test and rate performance of louvers per AMCA 500L-99.
- C. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

1.3 REFERENCES

- A. ANSI/ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Inlets and Outlets.
- B. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. SMACNA - Duct Construction Standards.

1.4 SUBMITTALS

- A. Submit product data under provisions of Section 23 0500.
- B. Submit schedule of inlets and outlets indicating type, size, location, application, and noise level.
- C. Review requirements of inlets and outlets as to size, finish, and type of mounting prior to submitting product data and schedules of inlets and outlets.
- D. Submit manufacturer's installation instructions.

1.5 REGULATORY REQUIREMENTS

- A. Conform to ANSI/NFPA 90A.

- B. Conform to ASHRAE 90.1.

1.6 EXTRA STOCK

- A. Provide clean filters in all filter return grilles at time of installation.
- B. Provide one additional set of replacement filters for all filter return grilles. Deliver to Owner at job site.

PART 2 - PRODUCTS

2.1 AIR TERMINALS - GRILLES AND REGISTERS

- A. Reference to a grille means an air supply, exhaust or transfer device without a damper.
- B. Reference to a register means an air supply, exhaust or transfer device with a damper.
- C. The type of unit, margin, material, finish, etc., shall be as shown on the drawing schedule and suitable for the intended use.
- D. All margins shall be compatible with ceiling types specified (including 'Thin-Line' T-bar lay-in grid system). Any discrepancies in contract documents shall be brought to the attention of the Architect/Engineer, in writing, prior to Bid Date. Submission of Bid indicates ceiling and air inlet and outlet types have been coordinated.
- E. The capacity and size of the unit shall be as shown on the drawings.
- F. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10-12 watts with a 10 dB room effect. .
- G. Refer to the drawings for construction material, color and finish, margin style, deflection, and sizes of grilles and registers.
- H. Provide with 3/4" blade spacing. Blades shall have steel friction pivots to allow for blade adjustment, plastic pivots are not acceptable.
- I. Corners of steel grilles and registers shall be welded and ground smooth before painting. Aluminum grilles and registers shall have staked corners.
- J. Where specified to serve registers, provide opposed blade volume dampers operable from the face of the register.
- K. Screw holes for surface fasteners shall be countersunk for a neat appearance. Provide concealed fasteners for installation in lay-in ceilings and as specified on the drawings.
- L. Manufacturers:
 - 1. Tuttle & Bailey
 - 2. Titus

3. Price
4. Nailor
5. Carnes
6. Metalaire
7. Krueger
8. Anemostat
9. Raymon Donco

2.2 AIR TERMINALS - ARCHITECTURAL SQUARE PANEL DIFFUSERS

- A. Reference to a diffuser means an air supply device, ceiling mounted, that shall diffuse air uniformly throughout the conditioned space.
- B. The type of unit, margin, material, finish, etc., shall be as shown on the drawing schedule. Flat-oval inlets are not acceptable for connection to flexible ducts.
- C. All margins shall be compatible with ceiling types specified (including 'Thin-Line' T-bar lay-in grid system). Any discrepancies in contract documents should be brought to the attention of the Architect/Engineer, in writing, prior to Bid Date. Submission of Bid indicates ceiling and air inlet and outlet types have been coordinated.
- D. The capacity and size of the unit shall be as shown on the drawings.
- E. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10-12 watts with a 10 dB room effect. .
- F. Diffusers shall be architectural solid square panel and flush with ceiling.
- G. The exposed surface shall be smooth, flat and free of visible fasteners. The face panel shall be 22 gauge steel with a rolled edge or shall be 18 gauge with a smooth ground, uniform edge.
- H. The back pan shall be one piece 22 gauge stamped and shall include an integral inlet. (Welded inlets and corner joints are not acceptable).
- I. Diffusers with a 24x24 back pan shall have a minimum 18x18 face panel size. Diffusers with a 12x12 back pan shall have a minimum 9x9 face panel size.
- J. The face panel shall be mechanically fastened to the back panel with steel components. (Plastic fasteners are not acceptable.)
- K. Manufacturers:
 1. Tuttle & Bailey
 2. Titus
 3. Price
 4. Nailor
 5. Carnes
 6. Metalaire
 7. Krueger
 8. Anemostat

9. Raymon Donco

2.3 AIR TERMINALS - LINEAR DIFFUSERS

A. Plenum Slot Diffusers (Lay-In):

1. The type of unit, margin size, material, finish, etc., shall be as shown on the Drawing Schedule. Flat-oval inlets are NOT acceptable for connection to flexible ducts. Provide sheet metal oval-to-round transition if required.
2. The capacity and size of the unit shall be as shown on the drawings.
3. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10-12 watts with a 10 dB room effect. [Noise in classrooms may not exceed 35 dBA or 55 dBC per ANSI Standard S12.60-2002 and ASHRAE 70].
4. Install T-bars on both sides of diffusers for lay-in ceiling system, install manufacturer frame for sheetrock or plaster ceiling system. Diffuser margins system shall be compatible with ceiling types specified, color to match ceiling system. Contractor shall coordinate margin types with ceilings prior to submitting shop drawings.
5. Linear diffusers and mounting frames shall be furnished as one piece up to 5' in length.
6. Diffusers shall be furnished with factory installed adjustable "ice tong" style pattern deflectors capable of providing 180° pattern adjustment.
7. A manual volume damper shall be furnished and installed by the Contractor in branch ductwork to each slot diffuser. Balancing dampers shall not be installed in supply plenum or at air outlet unless otherwise indicated on the drawings.
8. Number and width of slots shall be as shown on the drawings.
9. Provide integral insulated plenum for each linear diffuser. Refer to linear diffuser supply plenum specification section for details.
10. Manufacturers:
 - a. Tuttle & Bailey ITPS
 - b. Carnes DA
 - c. Price TBD
 - d. Krueger PTBS
 - e. Nailor 5800
 - f. Titus TBD
 - g. Metalaire
 - h. Anemostat API
 - i. Raymon Donco SAT

2.4 AIR TERMINALS - LINEAR DIFFUSER SUPPLY PLENUM

- A. Linear diffusers shall be provided with field fabricated or prefabricated supply plenums. Plenum shall be a minimum of 2-1/2" wider than total slot width, minimum length of slot, and minimum height of 10". Plenums with end fed duct connections shall not exceed 8' in length. The cross sectional area of the plenum shall be designed for a maximum velocity of 500 fpm and the aspect ratio shall be limited to a width-to-height ratio of less than 1.5. Plenums with side outlets shall be designed for a maximum velocity of 600 fpm and inlet ducts to plenum shall be spaced 5' on center maximum. Inlet ducts to plenums shall have a maximum velocity of 900 fpm. Flat-oval inlets are NOT acceptable for connection to flexible ducts. Provide sheet metal oval-to-round transition if required.

- B. Plenum shall be constructed with 24 gauge galvanized steel and shall have side inlets unless shown otherwise on the drawings. Refer to Ductwork Application Schedule in Section 23 3100 for insulation requirements.
- C. End caps and required accessories shall be integral with the plenum or furnished and installed by the Mechanical Contractor.
- D. A manual volume damper shall be furnished and installed by the Mechanical Contractor in branch ductwork to each slot diffuser. Balancing dampers shall not be installed in supply plenum or at air outlet unless otherwise indicated on the drawings
- E. Prefabricated plenums shall be by the same manufacturer as the linear diffuser or Kees Inc.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General Installation Requirements:
 - 1. Install items in accordance with manufacturers' instructions.
 - 2. Check location of inlets and outlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.
 - 3. Install diffusers to ductwork with air tight connections.
 - 4. Flexible ducts shall NOT be joined to flat-oval connections. Provide sheet metal oval-to-round transitions where required.
 - 5. Supply grille and register blades shall be aimed in the field to provide adequate air distribution in the space. All return grilles and registers blades shall be oriented to minimize sight distance beyond installed device.
- B. Volume Damper:
 - 1. Provide manual volume dampers on duct take-off to diffusers when there are multiple connections to a common duct. Locate volume dampers as far as possible from the air inlet or outlet.
- C. Maintaining Duct Cleanliness:
 - 1. When grilles, registers, and diffusers are installed, Contractor shall prevent construction dust, dirt, and debris from entering ductwork as required by Section 23 0500.

END OF SECTION

SECTION 23 7416.12 - PACKAGED ROOFTOP AIR CONDITIONING UNITS 25 TON AND BELOW

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Packaged Rooftop Unit.
- B. Unit Controls.
- C. Roof Mounting Frame and Base.
- D. Economizers.

1.2 QUALITY ASSURANCE

- A. All insulation inside the unit and in the air stream must comply with the requirement of NFPA 90A (maximum flame spread of 25 and maximum smoke developed of 50).
- B. All units must be UL or ETL listed and must contain UL labeled components.
- C. Fans shall be tested and rated in cabinet in accordance with AMCA Standard 210. All fan assemblies shall be dynamically balanced in cabinet at final assembly.
- D. Conform to ASHRAE 90.1 IECC.
- E. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

1.3 REFERENCES

- A. AHRI 210 - Unitary Air Conditioning Equipment.
- B. AHRI 240 - Air Source Unitary Heat Pump Equipment.
- C. AHRI 270 - Sound Rating of Outdoor Unitary Equipment.
- D. ASHRAE 37 - Methods of Testing for Rating Unitary Air Conditioning and Heat Pump Equipment.
- E. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- F. NFPA 70 - National Electrical Code.
- G. NFPA 90A - Installation of Air Conditioning and Ventilating System.

H. UL - Underwriters' Laboratory.

I. USGBC - Leadership in Energy and Environmental Design (LEED) Rating System.

1.4 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 0500.

B. Indicate electrical service and duct connections on shop drawings or product data.

C. Submit manufacturer's installation instructions.

D. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

E. Provide 8 octave maximum sound power levels at unit discharge and return connection.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect units from physical damage by storing off site until roof mounting frames are in place, ready for immediate installation of units.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include manufacturer's descriptive literature, installation instructions, maintenance and repair data, and parts listing.

1.7 WARRANTY

A. Provide five (5) year manufacturer's warranty for compressors.

B. Provide twenty five (25) year manufacturer's warranty for heat exchanger.

C. Provide three (3) year manufacturer's warranty for controls and electrical components (thermostats, VFD, etc.).

1.8 MAINTENANCE SERVICE

A. Contractor shall furnish complete service and maintenance of packaged roof top units for one year from Date of Substantial Completion.

B. Provide maintenance service with a two-month interval as maximum time period between calls. Provide 24-hour emergency service on breakdowns and malfunctions.

C. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of four (quarterly) filter replacements, minimum of one fan belt replacement, and controls checkout, seasonal adjustments, and recalibrations.

- D. Submit copy of service call work order or report and include description of work performed to Owner and Architect/Engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: The scheduled manufacturer is the Basis of Design. The Contractor is responsible for all costs, schedule impacts, and construction coordination, including design costs and regulatory agency approvals, related to using a specified alternate product other than the Basis of Design. Refer to Section 23 0500 for additional information.
- B. Trane
- C. Daikin
- D. Carrier
- E. Valent
- F. Aeon

2.2 MANUFACTURED UNITS

- A. Provide roof-mounted units having, air source heat pump, electric heating elements, and electric refrigeration.
- B. Unit shall be self-contained, packaged, factory assembled, pre-wired and tested, consisting of cabinet and frame, supply fan, exhaust fan, air source heat pump, electric heating elements, controls, air filters, condenser coil, condenser fan, and a full refrigerant charge, hot gas reheat and energy recovery wheel.
- C. Unit shall be furnished with non-fused disconnect switch, short fuse protection of all internal electrical components, and all necessary motor starters, contactors, and over-current protection.

2.3 FABRICATION

- A. Cabinet: Galvanized steel with baked enamel finish, access doors or removable access panels with quick fasteners locking door handle type with piano hinges. Access doors shall be provided at each section (e.g., filter section, supply fan section, etc.). All exterior access panels must be permanently labeled on the outside indicating what is behind the panel. Structural members shall be minimum 18 gauge, with access doors or removable panels of minimum 20 gauge.
- B. Outside Air Intakes: The outside air intakes shall be located a minimum of 15 inches above the roof mounting curb to minimize the effect of heat pickup from the roof during the natural cooling cycle and the effects of snow on the roof during winter operation. Each air intake shall be furnished with rain eliminators.

- C. Insulation: All sections shall be double wall, foam injected casings. Minimum of 2" antimicrobial two component rigid foam insulation, metal encapsulated with no exposed edges. Initial R-value of 6.7 per inch of thickness.
 - D. Air Filters: Aluminum Mesh Filters and Galvanized Mesh birdscreen shall be installed on the intake of the unit. In addition, one row of 2 inch MERV-8 rated prefilters and 2 inch MERV-13 final filter installed prior to the evaporator coil.
- 2.4 ROOF MOUNTING FRAME AND BASE
- A. Roof Mounting Curb: Minimum 14 inches high, minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.
- 2.5 FANS/MOTORS
- A. Fans:
 - 1. Supply Fans: centrifugal; SWSI plenum with factory installed Variable Frequency Drive
 - 2. Exhaust Fans: SWSI plenum fan with factory installed Variable Frequency Drive
 - 3. All fans shall be aluminum or composite construction with fan shaft: turned, ground and polished steel; keyed to wheel hub.
 - 4. Fan and motor assemblies shall be resiliently mounted.
 - 5. Direct drive motor.
 - 6. All fan bearings must be capable of being lubricated by easily accessible grease fittings.
 - 7. All fans must be statically and dynamically balanced.
 - 8. All Fans to be provided with Fan Piezo Rings for airflow measuring by manufacturer
 - B. Motors:
 - 1. Motors shall be "variable frequency drive rated" when controlled by VFDs. Refer to Section 23 0513.
 - 2. No equipment shall be selected or operate above 90% of its motor nameplate rating.
 - 3. Motor shall have 1.15 service factor.
 - 4. ECM motors may be provided.
- 2.6 ELECTRIC HEATING COIL
- A. Finned tube heating elements easily accessible with automatic reset thermal cut-out, built-in magnetic contactors, galvanized steel frame, fused disconnect,.
 - B. Controls shall start supply fan before electric elements are energized and continue operating until air temperature reaches minimum setting, with switch for continuous fan operation.
 - C. Heating shall have modulating SCR control.
- 2.7 EVAPORATOR COIL
- A. Provide copper tube with aluminum fin coil assembly.

- B. Install a drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. The drain pans shall extend the entire width of each coil, including piping and header if in the air stream. The length shall be as necessary to limit water droplet carryover beyond the drain pan to 0.0044oz per ft² of face area per hour under peak sensible and peak dew point design conditions, considering both latent load and coil face velocity. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8" per foot.
 - C. Provide capillary tubes or thermostatic expansion valves for units of 6 tons capacity and less, and thermostatic expansion valves and alternate row circuiting for units 7.5 tons cooling capacity and larger.
 - D. Provide insulation on liquid refrigerant and suction piping between compressor and evaporator coil where not protected by drain pans. Insulation shall be elastomeric cellular foam; ANSI/ASTM C534; flexible plastic; 0.27 maximum 'K' value at 75°F, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723). Maximum 1" thick per layer where multiple layers are specified.
 - E. Drain Pan Condensate Overflow Switch: Float with integral magnet overflow switch conforming to UL508. Factory installed in drain pan and wired to shut the rooftop unit down with a fault alarm. No standby power required.
- 2.8 HOT GAS REHEAT COIL
- A. Provide copper tube with aluminum fin coil assembly.
 - B. Valves to reroute hot refrigerant gas from the discharge line of the compressor through the reheat coil.
 - C. Modulating Hot gas Reheat coil.
- 2.9 COMPRESSOR
- A. Provide hermetic or semi-hermetic compressors (quantity as scheduled on drawings), 3600 rev/min maximum, resiliently mounted with positive lubrication, crankcase heater for operation down to 0°F, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gauge ports, and filter drier.
 - B. Five minute timed off circuit shall delay compressor start.
 - C. Provide capacity control by providing digital scrolls.
 - D. For heat pump units, provide reversing valve, suction line accumulator, discharge muffler, flow control check valve, and solid-state defrost control utilizing thermistors.
 - E. The use of hydrochlorofluorocarbon (HCFC) or chlorofluorocarbon (CFC) based refrigerants is prohibited.

- F. Refrigerant type and quantities shall meet the ozone depletion and global climate change limits of LEED credit EAc4, Enhanced Refrigerant Management (follow the latest edition at the time of bidding or as referenced in these specifications).

2.10 CONDENSER

- A. Provide copper tube aluminum fin coil assembly with sub-cooling rows.
- B. Provide direct drive low noise blade design propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be aluminum or composite material.
- C. Provide refrigerant pressure switches to cycle condenser fans.
- D. Provide hail guards on all condenser coils.
- E. Liquid and discharge isolation valves with staged and digital scrolls.
- F. Fan motors shall be an ECM type motor for proportional control. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.

G. MIXING SECTION

- H. Dampers: Provide remote controlled outside and return air dampers with damper operator and remote rheostat for adjusting outside air quantity.
- I. Gaskets: Provide tight fitting dampers with edge gaskets. Gaskets must be mechanically fastened (use of adhesive alone shall not be acceptable). Damper blades shall be gasketed with side seals to provide an air leakage rate of Class 1A at 1" w.c. pressure differential for a 24"x 24" damper. A barometric exhaust damper shall be provided to exhaust air out the back of the unit. A bird screen shall be provided to prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges. Control of the dampers shall be by a factory installed direct coupled actuator.
- J. Damper Actuator: 24 volt with gear train sealed in oil, with spring return on units 7.5 tons cooling capacity and larger.

2.11 ECONOMIZERS

- A. Factory installed by approved rooftop unit manufacturer with fully modulating motorized outside air and return air dampers.
- B. To be controlled by differential enthalpy with fixed dry-bulb controller with minimum position setting.
- C. Shall be equipped with 100% capable relief barometric damper relieving up to 100% return air and sealed to meet ASHRAE 90.1 requirements.

- D. Shall be capable of introducing up to 100% outside air.
- E. Shall maintain minimum airflow into the building during occupied period and provide design ventilation rate for full occupancy.
- F. Dampers shall be capable of completely closing when unit is in unoccupied mode.
- G. Outside air damper normally closed and return air damper normally open.
- H. Provide factory installed and tested, outdoor air monitor that controls outdoor air $\pm 15\%$ accuracy down to 40 cfm per ton.
- I. Provide a field installed duct/space-mounted CO₂ sensor. Outside air damper position shall modulate between the demand control ventilation limit (minimum position setpoint) and the ventilation limit (maximum non-economizer position setpoint) to satisfy the space requirements. Damper position shall be controlled to the greater of the two command signals, either minimum outside airflow or space IAQ (CO₂).
- J. Economizer Fault Detection and Diagnostics (FDD):
 - 1. Air-cooled unitary direct-expansion units that are equipped with an economizer shall include a fault detection and diagnostics system complying with the following:
 - a. The following temperature sensors shall be permanently installed to monitor system operation:
 - 1) Outside air.
 - 2) Supply air.
 - 3) Return air.
 - b. Temperature sensors shall have an accuracy of $\pm 2^\circ\text{F}$ over the range of 40°F to 80°F .
 - c. Refrigerant pressure sensors, where used, shall have an accuracy of ± 3 percent of full scale.
 - d. The unit controller shall be configured to provide system status by indicating the following:
 - 1) Free cooling available.
 - 2) Economizer enabled.
 - 3) Compressor enabled.
 - 4) Heating enabled.
 - 5) Mixed air low limit cycle active.
 - 6) The current value of each sensor.
 - e. The unit controller shall be capable of manually initiating each operating mode so that the operation of compressors, economizers, fans, and the heating system can be independently tested and verified.
 - f. The fault detection and diagnostics system shall be configured to detect the following faults:

- 1) Air temperature sensor failure/fault.
- 2) Not economizing when the unit should be economizing.
- 3) Economizing when the unit should not be economizing.
- 4) Damper not modulating.
- 5) Excess outdoor air.

- g. The unit shall be configured to report faults to a fault management application available for access by day-to-day operating or service personnel or annunciated locally on zone thermostats.

2.12 POWER EXHAUST

- A. Factory installed by economizer supplier or compatible equivalent.
- B. Controlled by economizer controls.
- C. Power exhaust shall be factory wired to electrical section complete with conduit, feeders, disconnect, and overcurrent protection. Power exhaust shall be energized based on building pressure or when dampers open past the adjustable setpoint of the economizer control.
- D. Must comply with Energy Code Fan Power Limitation formula.
- E. Fans:
1. Exhaust Fans: Direct Drive VFD Driven
 2. All fans shall be aluminum or composite construction
 3. Fan and motor assemblies shall be resiliently mounted
 4. Direct drive motor.
 5. All fan bearings must be capable of being lubricated by easily accessible grease fittings.
 6. All fans must be statically and dynamically balanced.
- F. Motors:
1. Motors shall be "variable frequency drive rated" when controlled by VFDs. Refer to Section 23 0513.
 2. No equipment shall be selected or operate above 90% of its motor nameplate rating.
 3. Motor shall have 1.15 service factor.
 4. ECM motors may be provided.

2.13 ELECTRICAL

- A. Provide with single point power connection to service all controls, dampers, outlet, and fans, complete with non-fused disconnect switch, short circuit protection of all internal electrical components, and all necessary motor starters, contactors, and over-current protection, transformer, and convenience outlet.
- B. All units must be so constructed that when the electrical section access panel is opened, all electrical power to the unit (with the exception of the 120 volt duplex convenience outlet) is disconnected by means of a single disconnect.

- C. All wiring must be labeled, numbered, and terminate in "spade clips". All terminal strips must be keyed to the wiring numbers. Each control device must be permanently labeled to indicate its function.
 - D. Wiring diagrams for all circuits must be permanently affixed to the inside of the electrical section access panel. The markings of terminal strips and wiring must agree with the numbering on the wiring diagrams.
 - E. All units shall include a transformer for controls and convenience outlet.
 - F. Only one power cable connection to the unit shall be necessary.
 - G. Motor shall include phase failure protection and prevent the motor from operation in the event of phase loss.
- 2.14 DDC TEMPERATURE CONTROLS
- A. Install standalone control module providing communication between unit controls and packaged DDC temperature control system.
 - B. Control module shall be compatible with temperature control system specified in Section 23 0900. Provide BACnet gateway for communication.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings and illustrated by the manufacturer.
- B. Verify that proper power supply is available.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Mount units on factory built roof mounting curb and provide watertight enclosure to protect ductwork and utility services. Install unit level.
- C. All field wiring shall be in accordance with the National Electrical Code.
- D. P-traps must be provided for all drain pans.
- E. Comb all coils to repair bent fins.

- F. Contractor shall coordinate unit access stair and walkway placement to ensure compliance with OSHA requirements.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Provide initial start-up and shutdown during first year of operation.

END OF SECTION

SECTION 23 8126 - SPLIT SYSTEM AIR CONDITIONING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Split system air conditioning wall units.

1.2 REFERENCES

- A. ARI 210 - Unitary Air Conditioning Equipment
- B. ARI 240 - Air Source Unitary Heat Pump Equipment
- C. ANSI NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
- D. ANSI/ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality.
- E. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- F. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- G. ASTM B1003 - Standard Specification for Seamless Copper Tube for Linesets.
- H. FS TT-C-490 - Cleaning Method and Pretreatment of Ferrous Surfaces for Organic Coatings.
- I. UL - Underwriters' Laboratories.

1.3 SUBMITTALS

- A. Submit shop drawings under provisions of Section 23 0500.
- B. Indicate drain, electrical, and refrigeration rough-in connections on shop drawings or product data.
- C. Submit manufacturer's installation instructions.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.
- B. Comply with manufacturer's installation instruction for rigging, unloading, and transporting units.
- C. Protect units from weather and construction traffic by storing in dry, roofed location until units are ready for immediate installation.

1.5 REGULATORY REQUIREMENTS

- A. Conform to ANSI/NFPA 90A for the installation of computer room air conditioning units.
- B. Conform to ASHRAE 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data.
- B. Include manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.7 WARRANTY

- A. Provide five (5) year manufacturer's warranty on all compressors.

PART 2 - PRODUCTS

2.1 SPLIT SYSTEM WALL MOUNTED UNITS

A. Manufacturers:

- 1. Carrier/Toshiba
- 2. LG
- 3. Panasonic/Sanyo
- 4. Samsung
- 5. Daikin Applied
- 6. Trane/Mitsubishi
- 7. Lennox

B. Manufactured Units:

- 1. Provide packaged, air-cooled, factory assembled, pre-wired and pre-piped unit consisting of cabinet, fans, filters, remote condensing unit, and controls. Wall-mounted units shall be furnished with integral wall mounting bracket and mounting hardware.
- 2. Assemble unit for wall-mounted installation with service access required.
- 3. Performance shall be as scheduled on the drawings.
- 4. Unit shall be rated per AHRI Standards 210/240 and listed in the AHRI directory as a matched system.
- 5. Provide unit with factory-supplied cleanable air filters.
- 6. The units shall be listed by Electrical Laboratories (ETL) in accordance with UL-1995 certification and bear the ETL label.
- 7. All wiring shall be in accordance with the National Electric Code (NEC).

C. Evaporator Cabinet and Frame:

- 1. Cabinet:

- a. Refer to schedule on drawings for mounting type (wall-mounted).
- b. Exposed units shall have a finished appearance with concealed refrigerant piping, condensate drain piping, and wiring connections.

D. Evaporator Fans and Motors:

1. Fans:

- a. The evaporator fan shall be direct drive with a single motor having permanently lubricated bearings.
- b. The fan shall be statically and dynamically balanced.
- c. The indoor fan shall have at least three speeds.

2. Motor:

- a. Direct driven, digitally controlled with multiple speeds. Permanently lubricated with internal overload protection.

E. Evaporator Coils (Direct Expansion):

1. Direct expansion cooling coil of seamless copper tubes expanded into aluminum fins.
2. Single refrigeration circuit with externally equalized expansion valve.
3. Coils shall be pressure tested at the factory.
4. A sloped, corrosion-resistant condensate pan with drain shall be provided under the coil.

F. Electrical Panel:

1. Service Connections, Wiring, and Disconnect Requirements: Conform to the National Electrical Code and local electrical codes.

G. Control:

1. The unit shall have a hard-wired 7-day programmable remote controller to operate the system. Provide wall mounting bracket for controller.
2. Remote controller shall have "automatic", "dry" (dehumidification), and "fan only" operating modes.
3. The remote controller shall have the following features:
 - a. On/Off power switch.
 - b. Mode Selector to operate the system in auto, cool, heat, fan, or dehumidification (dry) operation.
 - c. Fan Setting to provide multiple fan speeds.
 - d. Swing Louver for adjusting supply louver discharge.
 - e. On/Off Timer for automatically switching the unit off or on.
 - f. Temperature Adjustment allows for the increase or decrease of the desired temperature.
 - g. Powerful Operation to allow quick cool down or heating up in the desired space to achieve maximum desired temperature in the shortest allowable time.

4. The remote controller shall perform fault diagnostic functions that may be system related, indoor or outdoor unit related depending on the fault code.
5. Temperature range on the remote controller shall be 64°F to 90°F in cooling mode and 50°F to 86°F in heating mode.
6. The indoor unit microprocessor shall have the capability to receive and process commands via return air temperature and indoor coil temperature sensors enabled by commands from the remote controller.
7. Integration: Manufacturer shall provide a BACnet interface with the building automation system in accordance with ASHRAE/ANSI Standard 135. This may be accomplished through a system integration panel or "gateway". Integration panels shall be provided as part of the split system.

H. Outdoor Unit:

1. General:
 - a. The outdoor unit shall be specifically matched to the corresponding indoor unit size. The outdoor unit shall be completely factory assembled and pre-wired with all necessary electronic and refrigerant controls.
2. Cabinet:
 - a. The outdoor unit shall be fabricated of galvanized steel, bonderized and coated with a baked enamel finish for corrosion protection.
3. Fan:
 - a. The fan shall be direct drive, propeller type fan with fan guard.
 - b. Fan blades shall be statically and dynamically balanced.
 - c. The fan shall have permanently lubricated type bearings.
 - d. Motor shall be protected by internal thermal overload protection.
 - e. Airflow shall be horizontal discharge.
4. Coil:
 - a. The outdoor coil shall be nonferrous construction with corrugated fin tube.
 - b. The coil shall be protected with an internal guard.
 - c. Refrigerant flow from the condenser shall be controlled via a metering device.
5. Compressor:
 - a. Hermetic or scroll refrigerant compressors with resilient suspension system, inverter driven, oil strainer, sight glass/moisture indicator, internal motor protection, high pressure switch, and crankcase heater.
 - b. The outdoor unit shall have an accumulator and four-way reversing valve.
6. Refrigerant:
 - a. Unit shall use R-410a.
 - b. The use of chlorofluorocarbon (CFC)-based refrigerants is prohibited.

- I. Integral Condensate Pump:
 1. Packaged unit matched to evaporator unit including float switch, pump, motor assembly, check valve, and reservoir.
 2. Provide alarm to indicate high level reservoir.
 3. Unit shall be powered from evaporator unit with appropriate field connections available.
- 2.2 PIPING
- A. Design Pressure: 450 psig; Maximum Design Temperature: 250°F
 - B. Type ACR Hard Drawn Seamless Copper Tube; Brazed Joint:
 1. 4" and under.
 2. Tubing: Type ACR hard drawn seamless copper tube, ASTM B280. Sizes indicated are nominal designation.
 3. Joints: Brazed with silver solder.
 4. Fittings: Wrought copper solder joint, ANSI B16.22.
 5. Special Requirements: All tubing shall be cleaned, dehydrated, pressurized with dry nitrogen, plugged and tagged by manufacturer "for refrigeration service". During brazing operations, continuously purge the interior of the pipe with nitrogen to prevent oxide formation.
 - C. Refrigerant linesets are not permitted.
- 2.3 INSULATION
- A. EPDM (NBR/PVC Blend is not permitted) elastomeric cellular foam; ANSI/ASTM C534; flexible plastic; 0.25 maximum 'K' value at 75°F, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723). Minimum 1/2" thick for pipe sizes less than 1-1/4" and 3/4" thick for pipe sizes 1-1/4" and above.
- 2.4 ROOF MOUNTING CURB
- A. Minimum 12 inches, minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.
- 2.5 EXPANSION COMPENSATION
- A. Assembly consisting of two flexible connectors, two copper flexible connectors, two 90° elbows, and a 180° return pipe. Unit shall be in the form of a pipe loop.
 - B. Connectors shall have corrugated copper hose bodies with copper braided casings.
 - C. Connectors shall be rated for 150 psi working pressure at 70°F.
 - D. Sizes 2" and smaller shall have copper sweat ends.
 - E. Connectors shall be suitable for 1/2" permanent misalignment.

F. Manufacturer:

1. Metraflex Type MLS

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that proper power supply is available.

3.2 INSTALLATION

A. General Installation Requirements:

1. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
2. Install units in accordance with manufacturer's instructions. Install all units level and plumb. Indoor units shall be installed using manufacturer's standard mounting hardware securely fastened to building structure.
3. Refer to Section 23 0529 for roof support rails for outdoor unit.
4. Coordinate the exact mounting location of all indoor and outdoor units with architectural and electrical work. Locate the indoor unit where it is readily accessible for maintenance and filter changes. Where outdoor units are located on the roof, locate at least 10' from the roof edge.
5. Verify locations of wall-mounted remote controllers with drawings and room details before installation. Coordinate mounting heights to be consistent with other wall-mounted devices. Height above finished floor shall not exceed 48".

B. Condensate Removal:

1. Install condensate piping with trap and route from drain pan to nearest drain. Discharge to nearest code-approved receptor or to a properly vented indirect waste fitting. Flush all piping before making final connections to units.

C. Comb all coils to repair bent fins.

D. Install new filters in the unit at Substantial Completion.

E. A factory-authorized service agent shall assist in commissioning the unit and inspecting the installation prior to startup. Submit startup report with O&M manuals.

3.3 REFRIGERANT PIPING

A. Install refrigerant piping from the indoor unit(s) to the condensing unit. Refrigerant pipe sizes, lengths, specialties and configurations shall be as recommended by the manufacturer. Evacuate refrigerant piping and fully charge system with refrigerant per manufacturer's requirements.

B. Provide weather-tight insulated roof curb to accommodate refrigerant piping and conduit roof penetrations.

- C. Insulate all refrigerant piping. Both liquid and suction lines shall be insulated between the indoor and outdoor units.
- D. Joining of Piping:
 - 1. Brazed Joints:
 - a. Make up joints with brazing filler metal conforming to ANSI/AWS A5.8. Cut copper tubing ends perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt, and grease just prior to brazing. Apply flux evenly, but sparingly, to all surfaces to be joined. Brazing filler metal with a flux coating may also be used. Heat joints uniformly to proper brazing temperature so braze filler metal flows to all mated surfaces. Wipe excess braze filler metal, leaving a uniform fillet around cup of fitting.
 - b. Flux shall conform to ANSI/AWS A5.31.
 - c. Remove composition discs and all seals during brazing if not suitable for a minimum of 840°F or greater than the melting temperature of the brazing filler metal, whichever is greater.
- E. Insulation:
 - 1. Insulate all refrigerant pipes between the heat pump and indoor units. This includes the liquid pipe, the suction pipe, the hot gas pipe, and the high/low pressure gas pipe. All fittings, valves, and specialty refrigerant components in the piping between the indoor and heat pump units shall also be insulated. The insulation shall have a continuous vapor barrier and shall pass through hangers and supports unbroken. All exterior insulated piping shall be painted with minimum of one (1) coat of UV resistant paint. Over size hangers and supports to allow the insulation to pass through unbroken. Following are the minimum insulation thicknesses unless noted otherwise in the manufacturer's literature or required by local AHJ:
 - a. Code/Year: **IECC 2021**
 - b. Refrigerant Suction (40°F & Below):
 - 1) Up to 1": 1/2"
 - 2) 1" and up: 1"
 - c. Refrigerant Suction (41°F to 60°F):
 - 1) Up to 1-1/2": 1/2"
 - 2) 1-1/2" and up: 1"

END OF SECTION

SECTION 23 8200 - TERMINAL HEAT TRANSFER UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cabinet Heaters.
- B. Electric Unit Heaters.

1.2 QUALITY ASSURANCE

- A. All filters shall be UL listed Class 1 or Class 2.
- B. All electrical equipment shall have a UL label.
- C. All louvers and dampers shall have AMCA certified ratings.
- D. Factory wired equipment shall conform to ANSI/NFPA 70.

1.3 REFERENCES

- A. ANSI/ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality.
- B. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. ANSI/NFPA 70 - National Electrical Code.

1.4 SUBMITTALS

- A. Submit shop drawings per Section 23 0500.
- B. Submit catalog data including arrangements, cross sections of cabinets, grilles, bracing, typical elevations.
- C. Submit schedules of equipment and enclosures indicating length, number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, and comparison of specified to actual heat output.
- D. Indicate mechanical and electrical service locations and requirements. Show deviations from scheduled products.
- E. Submit manufacturers' installation instructions.
- F. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Protect units from physical damage by storing in protected areas and leaving factory covers in place.

1.6 REGULATORY REQUIREMENTS

- A. Conform to ASHRAE 90.1.

1.7 OPERATION AND MAINTENANCE DATA

- A. Submit manufacturer's operation and maintenance data. Include operating, installation, maintenance and repair data, and parts listings.

PART 2 - PRODUCTS

2.1 ELECTRIC CABINET HEATERS

- A. Forced air wall mounted heaters shall include cabinet, fan, motor, coil, inlet grille and discharge grille.
- B. Coil: Electric dual element with finned steel sheaths.
- C. Blower shall have a two-speed split capacitor motor and a concealed unit mounted "Off-Low-High" fan speed switch.
- D. Power connections, circuit breaker, or disconnect shall be provided by the E.C.
- E. Units shall have 1" disposable filters ahead of all coils.
- F. Cabinets shall have 16 gauge exposed surfaces, 18 gauge concealed surfaces, and no exposed plastic parts.
- G. Baked enamel finish. Color selected by Architect.
- H. Manufacturers:
 - 1. Trane.
 - 2. Berko.
 - 3. Redd-i.

2.2 ELECTRIC UNIT HEATERS

- A. Horizontal or vertical discharge as scheduled on the drawings.
- B. Horizontal units shall have adjustable outlet louvers.
- C. Metal sheathed fin tube electric heating elements.

- D. Casing: Heavy gauge steel with baked enamel finish.
- E. Automatic reset thermal overload wired for instantaneous pilot operation of contactor holding coil.
- F. Motors shall be totally enclosed continuous duty with built-in thermal overload protection.
- G. Provide unit mounted and wired disconnect.
- H. Provide resiliently mounted fan guard/motor support.
- I. Fans: Direct drive propeller type, factory balanced.
- J. Manufacturers:
 - 1. Trane.
 - 2. Chromalox.
 - 3. Modine.
 - 4. Reznor.
 - 5. Berko.
 - 6. Redd-i.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General Installation Requirements:
 - 1. Install all products per manufacturers' instructions.
 - 2. Coordinate recess sizes for recessed equipment.
 - 3. Protect units with protective covers during construction.
 - 4. Comb all coils to repair bent fins.

3.2 CLEANING

- A. After construction is complete, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- B. Touch-up marred or scratched surfaces of factory-finished cabinets, with materials furnished by manufacturer.
- C. Install new filters.

END OF SECTION

SECTION 26 0500 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 26 Sections. Also refer to Division 1 - General Requirements. This section is also applicable to Fire Alarm and Detection Systems Section 28 3100.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 REFERENCES

- A. NFPA 70 - National Electrical Code (NEC)

1.3 SCOPE OF WORK

- A. This Specification and the associated drawings govern furnishing, installing, testing and placing into satisfactory operation the Electrical Systems.
- B. The Contractor shall furnish and install all new materials as indicated on the drawings, and/or in these specifications, and all items required to make the portion of the Electrical Work a finished and working system.
- C. Separate contracts will be awarded for the following work.
- D. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.
- E. Separate contracts will be awarded for the following work. The division of work listed below is for the contractors' convenience and lists a normal breakdown of the work. Please refer to the Construction Manager's scope statements for complete scope of work description.
- F. Description of Systems shall be as follows:
 - 1. Electrical power system to and including luminaires, equipment, motors, devices, etc.
 - 2. Electrical power service system from the Utility Company to and including service entrance equipment, distribution and metering.
 - 3. Grounding system.
 - 4. Fire alarm system.
 - 5. Wiring of equipment furnished by others.
- G. Work Not Included:
 - 1. Telecommunications cabling will be by Division 27, in raceways and conduits furnished and installed as part of the Electrical work.

2. Temperature control wiring for plumbing and HVAC equipment (unless otherwise indicated) will be by other Contractors.

1.4 OWNER FURNISHED PRODUCTS

- A. The Owner will supply manufacturer's installation data for Owner-purchased equipment for this project.
- B. This Contractor shall make all electrical system connections shown on the drawings **or** required for fully functional units.
- C. This Contractor is responsible for all damage to Owner furnished equipment caused during installation.

1.5 WORK SEQUENCE

- A. All work that will produce excessive noise or interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during unoccupied hours. The Owner reserves the right to determine when restricted construction hours are required.

1.6 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL, and CONTROL CONTRACTORS

- A. Division of work is the responsibility of the Prime Contractor. Any scope of work described at any location on the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described on the contract documents on bid day. The following division of responsibility is a guideline based on typical industry practice.
- B. Definitions:
 1. "Mechanical Contractors" refers to the Contractors listed in Division 21/22/23 of this Specification.
 2. "Technology Contractors" refers to the Contractors furnishing and installing systems listed in Division 27/28 of this Specification.
 3. Motor Power Wiring: The single phase or 3 phase wiring extending from the power source (transformer, panelboard, feeder circuits, etc.) through disconnect switches and motor controllers to, and including the connections to the terminals of the motor.
 4. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case, the devices are usually single phase, have "Manual-Off-Auto" provisions, and are usually connected into the motor power wiring through a manual motor starter.
 5. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.

6. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. When the motor power wiring exceeds 120 volts, a control transformer is usually used to give a control voltage of 120 volts.
7. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring that directly powers or controls a motor used to drive equipment such as fans, pumps, etc. This wiring will be from a 120-volt source and may continue as 120 volt, or be reduced in voltage (24 volt), in which case a control transformer shall be furnished as part of the temperature control wiring.
8. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.
9. Low Voltage Technology Wiring: The wiring associated with the technology systems, used for analog or digital signals between equipment.
10. Telecommunications/Technology Rough-in: Relates specifically to the backboxes, necessary plaster rings and other miscellaneous hardware required for the installation or mounting of telecommunications/technology information outlets.

C. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractors' responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors, etc. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals approved. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall furnish complete wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.
4. The Electrical Contractor shall establish electrical utility elevations prior to fabrication and installation. The Electrical Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
 - a. Luminaires.
 - b. Gravity flow piping, including steam and condensate.
 - c. Electrical bus duct.
 - d. Sheet metal.
 - e. Cable trays, including access space.
 - f. Other piping.
 - g. Conduits and wireway.

D. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment furnished by the Mechanical Contractor.
2. Assumes all responsibility for miscellaneous items furnished by the Mechanical Contractor that require wiring but are not shown on the electrical drawings or specified in the Electrical Specification. If items such as relays, flow switches, or interlocks are required to make the mechanical system function correctly or are required by the manufacturer, they are the responsibility of the Mechanical Contractor.
3. Assumes all responsibility for Temperature Control wiring, if the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Temperature Control Contractor's or Subcontractor's Responsibility:

1. Wiring of all devices needed to make the Temperature Control System functional.
2. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Contractor or Subcontractor.
3. Coordinating equipment locations (such as PE's, EP's, relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.

F. Electrical Contractor's Responsibility:

1. Furnishes and installs all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor in the Mechanical Drawings or Specifications.
2. Installs and wires all remote-control devices furnished by the Mechanical Contractor or Temperature Control Contractor when so noted on the Electrical Drawings.
3. Furnishes and installs motor control and temperature control wiring, when noted on the drawings.
4. Furnishes, installs, and connects all relays, etc., for automatic shutdown of certain mechanical equipment (supply fans, exhaust fans, etc.) upon actuation of the Fire Alarm System.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

G. General (Electrical/Technology):

1. "Electrical Contractor" as referred to herein shall be responsible for scope listed in Division 27/28 of this specification when the "Suggested Matrix of Scope Responsibility" indicated work shall be furnished and installed by the EC. Refer to the Contract Documents for this "Suggested Matrix of Scope Responsibility".
2. The purpose of these Specifications is to outline the Electrical and Technology Contractor's work responsibilities as related to Telecommunications Rough-in, conduit, cable tray, power wiring and Low Voltage Technology Wiring.

3. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals approved. Therefore, only known wiring, conduits, raceways and electrical power related to such items is shown on the Technology drawings. Other wiring, conduits, raceways, junction boxes and electrical power not shown on the Technology Drawings but required for operation of the systems is the responsibility of the Technology Contractor and included in said Contractor's bid.
4. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of Technology systems, the final installation shall not be until a coordination meeting between the Electrical Contractor and the Technology Contractor has convened to determine the exact location and requirements of the installation.
5. Where the Electrical Contractor is required to install cable tray that will contain Low Voltage Technology Wiring, installation shall not begin prior to a coordination review of the cable tray shop drawings by the Technology Contractor.

H. Technology Contractor's Responsibility:

1. Assumes all responsibility for the low voltage technology wiring of all systems, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being furnished and installed by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility".
3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined herein).
4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of technology equipment which is required to be bonded to the telecommunications ground bar.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.7 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
 - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
 - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.

- d. Maintenance clearances and code-required dedicated space shall be included.
 - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
 - a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
 3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.
- B. Participation:
1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
 2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process.
 - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
 3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.
- C. Drawing Requirements:
1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
 - a. Scale of drawings:
 - 1) General plans: 1/4 Inch = 1'-0" (minimum).
 - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
 - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
 - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
 - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).

2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
 - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
 - b. Potential layout changes shall be made to avoid additional access panels.
 - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
 - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
 - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign-off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.

12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.8 QUALITY ASSURANCE

A. Contractor's Responsibility Prior to Submitting Pricing/Bid Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guides, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Architect/Engineer any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Architect/Engineer will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer are acceptable.
2. All Contractors and subcontractors shall employ only workmen who are skilled in their trades. At all times, the number of apprentices at the job site shall be less than or equal to the number of journeymen at the job site.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City of Evanston Codes, Laws, Ordinances and other regulations having jurisdiction.
2. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
3. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
4. All changes to the system made after the letting of the contract to comply with codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.
5. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
6. If there are no local codes having jurisdiction, the current issue of the National Electrical Code shall be followed.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
 2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
 3. Pay all charges for permits or licenses.
 4. Pay all fees and taxes imposed by State, Municipal, and other regulatory bodies.
 5. Pay all charges arising out of required inspections by an authorized body.
 6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
 7. Where applicable, all fixtures, equipment and materials shall be listed by Underwriter's Laboratories, Inc. or a nationally recognized testing organization.
 8. Pay all telephone company charges related to the service or change in service.
- E. Utility Company Requirements:
1. Secure from the private or public utility company all applicable requirements.
 2. Comply with all utility company requirements.
 3. The Owner shall make application for and pay for new electrical service equipment and installation. The Contractor shall coordinate schedule and requirements with the Owner and Utility Company.
 4. The contractor is responsible for completing utility requested forms and sharing utility requested load data from the construction documents.
 5. Verify approved manufacturers and equipment with the Utility Company.
 6. The Owner shall apply and pay for any changes for removal of existing electrical service by the utility company. The Contractor shall verify approved manufacturers and equipment with the Utility Company.
- F. Examination of Drawings:
1. The drawings for the electrical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
 2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of raceways to best fit the layout of the job. Conduit entry points for electrical equipment including, but not limited to, panelboards, switchboards, switchgear and unit substations, shall be determined by the Contractor unless noted in the contract documents.
 3. Scaling of the drawings will not be sufficient or accurate for determining these locations.
 4. Where job conditions require reasonable changes in arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
 5. Because of the scale of the drawings, certain basic items, such as junction boxes, pull boxes, conduit fittings, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
 6. If an item is either shown on the drawings or called for in the specifications, it shall be included in this contract.
 7. The Contractor shall determine quantities and quality of material and equipment required from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater and better-quality number shall govern.

8. Where used in electrical documents the word "furnish" shall mean supply for use, the word "install" shall mean connect up complete and ready for operation, and the word "provide" shall mean to supply for use and connect up complete and ready for operation.
9. Any item listed as furnished shall also be installed unless otherwise noted.
10. Any item listed as installed shall also be furnished unless otherwise noted.

G. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

H. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any conduit, conductors, wireways, bus duct, fittings, etc.

1.9 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

Referenced Specification Section	Submittal Item
26 05 26	Grounding and Bonding
26 09 13	Power Monitoring and Controls System
26 09 33	Lighting Control System
26 24 13	Switchboards
26 24 16	Panelboards
26 24 19	Motor Control

Referenced Specification Section	Submittal Item
26 27 26	Wiring Devices
26 28 16	Disconnect Switches
26 43 00	Surge Protection Devices
26 51 19	LED Lighting
26 52 15	Emergency Lighting Inverter
28 31 00	Fire Alarm and Detection Systems

B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:

- a. Date
- b. Project title and number
- c. Contractor's name and address
- d. Division of work (e.g., electrical, plumbing, heating, ventilating, etc.)
- e. Description of items submitted and relevant specification number
- f. Notations of deviations from the contract documents
- g. Other pertinent data

2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:

- a. Date
- b. Project title and number
- c. Architect/Engineer
- d. Contractor and subcontractors' names and addresses
- e. Supplier and manufacturer's names and addresses
- f. Division of work (e.g., electrical, plumbing, heating, ventilating, etc.)
- g. Description of item submitted (using project nomenclature) and relevant specification number
- h. Notations of deviations from the contract documents
- i. Other pertinent data
- j. Provide space for Contractor's review stamps

3. Composition:

- a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
- b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
- c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
5. Contractor's Approval Stamp:
 - a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
 - b. Unstamped submittals will be rejected.
 - c. The Contractor's review shall include, but not be limited to, verification of the following:
 - 1) Only approved manufacturers are used.
 - 2) Addenda items have been incorporated.
 - 3) Catalog numbers and options match those specified.
 - 4) Performance data matches that specified.
 - 5) Electrical characteristics and loads match those specified.
 - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
 - 7) Dimensions and service clearances are suitable for the intended location.
 - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
 - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
 - d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
 - e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
6. Submittal Identification and Markings:
 - a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
 - b. The Contractor shall clearly indicate the size, finish, material, etc.
 - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
 - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.

10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer before releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
 - a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.
16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. Submittal file name: 26 XX XX.description.YYYYMMDD
 - b. Transmittal file name: 26 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.10 CHANGE ORDERS

- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.

- B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.
- C. Change order work shall not proceed until authorized.

1.11 PRODUCT DELIVERY, STORAGE, HANDLING and MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage.
- B. Keep all materials clean, dry and free from damaging environments.
- C. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Electrical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

1.12 WARRANTY

- A. Provide one-year warranty for all fixtures, equipment, materials, and workmanship.
- B. The warranty period for all work in this specification Division shall commence on the date of Substantial Completion or successful system performance whichever occurs later. The warranty may also commence if a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization of the Owner. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- C. Warranty requirements extend to correction, without cost to the Owner, of all work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage due to defects or nonconformance with contract documents excluding repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

1.13 INSURANCE

- A. This Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

1.14 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the manufacturer for which a catalog number is given is the basis for job design and establishes the quality.

- B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors. The Architect/Engineer shall make the final determination of whether a product is equivalent.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractors part or on the part of other Contractors whose work is affected.
- D. Voluntary add or deduct prices for alternate materials may be listed on the bid form. These items will not be used in determining the low bidder. This Contractor assumes all costs incurred as a result of using the offered material or equipment on the Contractors part or on the part of other Contractors whose work is affected.
- E. All material substitutions requested after the final addendum must be listed as voluntary changes on the bid form.

1.15 LEED REQUIREMENTS

- A. This project is pursuing a LEED certification in accordance with USGBC LEED Rating System for New Construction v4. The Contractor shall provide all services and documentation necessary to achieve this rating.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All items of material having a similar function (e.g., safety switches, panelboards, switchboards, contactors, motor starters, dry type transformers) shall be of the same manufacturer unless specifically stated otherwise on drawings or elsewhere in specifications.

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 EXCAVATION, FILL, BACKFILL, COMPACTION

A. General:

1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found by calling 811.
2. The Contractor shall do all excavating, filling, backfilling, compacting, and restoration in connection with the work.

B. Excavation:

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.
2. If excavations are carried in error below indicated levels, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer shall be placed in such excess excavations under the foundation. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
3. Trim bottom and sides of excavations to grades required for foundations.
4. Protect excavations against frost and freezing.
5. Take care in excavating not to damage surrounding structures, equipment or buried pipe. Do not undermine footing or foundation.
6. Perform all trenching in a manner to prevent cave-ins and risk to workmen.
7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
8. If satisfactory bearing soil is not found at the indicated levels, immediately notify the Architect/Engineer or their representative, and do no further work until the Architect/Engineer or their representative gives further instructions.
9. Excavation shall be performed in all ground conditions, including rock, if encountered. Bidders shall visit the premises and determine the soil conditions by actual observations, borings, or other means. The cost of all such inspections, borings, etc., shall be borne by the bidder.

10. If a trench is excavated in rock, a compacted bed with a depth of 3" (minimum) of sand and gravel shall be used to support the conduit unless masonry cradles or encasements are used.
 11. Mechanical excavation of the trench to line and grade of the conduit or to the bottom level of masonry cradles or encasements is permitted, unless otherwise indicated on the electrical drawings.
 12. Mechanical excavation of the trench to line and grade where direct burial cables are to be installed is permitted provided the excavation is made to a depth to permit installation of the cable on a fine sand bed at least 3 inches deep.
- C. Dewatering:
1. Furnish, install, operate and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.
- D. Underground Obstructions:
1. Known underground piping, conduit, feeders, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Review all Bid Documents for all trades on the project to determine obstructions indicated. Take great care in making installations near underground obstructions.
 2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.
- E. Fill and Backfilling:
1. No rubbish or waste material is permitted for fill or backfill.
 2. Provide all necessary sand and/or CA6 for backfilling.
 3. Native soil materials may be used as backfill if approved by the Geotechnical Engineer.
 4. Dispose of the excess excavated earth as directed.
 5. Backfill materials (native soil material, sand, and/or CA6) shall be suitable for required compaction, clean and free of perishable materials, frozen earth, debris, earth with a high void content, and stones greater than 4 inches in diameter. Water is not permitted to rise in unbackfilled trenches.
 6. Backfill all trenches and excavations immediately after installing of conduit, or removing forms, unless other protection is directed.
 7. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Spread fill and backfill materials in 6" uniform horizontal layers with each layer compacted separately to required density.
 8. For conduits that are not concrete encased, lay all conduits on a compacted bed of sand at least 3" deep. Backfill around conduits with sand, in 6" layers and compact each layer.
 9. Conduits that are concrete encased or in a ductbank, conduit spacers, and cradles shall be installed on a bed of compacted CA-6 gravel. Refer to conduit section for backfilling and ductbank requirements.
 10. Backfill with native soil material (if approved) or sand up to grade for all conduits under slabs or paved areas. All other conduits shall have sand backfill to 6" above the top of the conduit.
 11. Place all backfill above the sand in uniform layers not exceeding 6" deep. Place then carefully and uniformly tamp each layer to eliminate lateral or vertical displacement.

12. Where the fill and backfill will ultimately be under a building, floor or paving, each layer of fill shall be compacted to 95% of the maximum density as determined by AASHTO Designation T-99 or ASTM Designation D-698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content as determined by AASHTO T-99 or ASTM D-698 test.
13. After backfilling of trenches, no superficial loads shall be placed on the exposed surface of the backfill until a period of 48 hours has elapsed.

F. Surface Restoration:

1. Where trenches are cut through graded, planted or landscaped areas, the areas shall be restored to the original condition. Replace all planting and landscaping features removed or damaged to its original condition. At least 6" of topsoil shall be applied where disturbed areas are to be seeded or sodded. All lawn areas shall be sodded unless seeding is called out in the drawings or specifications.
2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition. Broken edges shall be saw cut and repaired as directed by Architect/Engineer.

3.3 ARCHITECT/ENGINEER OBSERVATION OF WORK

A. The contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Placing fill over underground and underslab utilities.
2. Covering exterior walls, interior partitions and chases.
3. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will review the installation and provide a written report noting deficiencies requiring correction. The contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation:

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
 - a. All junction boxes are closed and identified in accordance with Section 26 0553 Electrical Identification.
 - b. Luminaires, including ceiling-mounted exit and emergency lights, are installed and operational.
 - c. Luminaire whips are supported above the ceiling.
 - d. Conduit identification is installed in accordance with Section 26 0553 Electrical Identification.
 - e. Luminaires are suspended independently of the ceiling system when required by these contract documents.
 - f. All wall penetrations have been sealed.
2. To prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.

3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to seven days elapsing, the Architect/Engineer may not recommend further payments to the contractor until full access has been provided.

3.4 PROJECT CLOSEOUT

- A. The following paragraphs supplement the requirements of Division 1.
- B. IDPH Pre-Occupancy Requirements:
 1. Each Contractor must submit all forms and certifications required by IDPH relating to their work at 85% completion of the project or when directed by the Owner/Architect/Engineer.
- C. Final Jobsite Observation:
 1. To prevent the Final Jobsite Observation from occurring too early, the Contractor shall review the completion status of the project and certify that the job is ready for the final jobsite observation.
 2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review. The Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
 3. It is understood that if the Architect/Engineer finds the job not ready for the final observation and additional trips and observations are required to bring the project to completion, the cost of the additional time and expenses incurred by the Architect/Engineer will be deducted from the Contractor's final payment.
 4. Contractor shall notify Architect/Engineer 48 hours prior to installation of ceilings or lay-in ceiling tiles.
- D. The following must be submitted before Architect/Engineer recommends final payment:
 1. Operation and maintenance manuals with copies of approved shop drawings.
 2. Record documents including reproducible drawings and specifications.
 3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of this Contractor and shall be signed by the Owner's representatives.
 4. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed and submit receipt to Architect/Engineer.
 5. Inspection and testing report by the fire alarm system manufacturer.
 6. Start-up reports on all equipment requiring a factory installation or start-up.
- E. Circuit Directories:
 1. Provide custom typed circuit directory for each branch circuit panelboard. Label shall include equipment name or final approved room name, room number, and load type for each circuit (examples: SUMP SP-1 or ROOM 101 RECEIPT). Revise directory to reflect circuit changes required to balance phase loads. Printed copies of the bid document panel schedules are not acceptable as circuit directories.

3.5 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. O&M file name: O&M.div26.contractor.YYYYMMDD
 - b. Transmittal file name: O&Mtransmittal.div26.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.

4. Copies of all factory inspections and/or equipment startup reports.
5. Copies of warranties.
6. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
7. Dimensional drawings of equipment.
8. Detailed parts lists with lists of suppliers.
9. Operating procedures for each system.
10. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
11. Repair procedures for major components.
12. Replacement parts and service material requirements for each system and the frequency of service required.
13. Instruction books, cards, and manuals furnished with the equipment.
14. Include record drawings of the one-line diagrams for each major system. The graphic for each piece of equipment shown on the one-line diagram shall be an active link to its associated Operation & Maintenance data.
15. Copies of all panel schedules in electronic Microsoft Excel spreadsheet (.xlsx) file. Each panelboard shall be a separate tab in the workbook.

3.6 INSTRUCTING THE OWNER'S REPRESENTATIVE

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of the complete systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by **FACTORY PERSONNEL** in the care, maintenance, and operation of the equipment and systems.
- C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.
- D. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can be present if desired.
- E. Minimum hours of instruction time for each item and/or system shall be as indicated in each individual specification section.
- F. Operating Instructions:
 1. Contractor is responsible for all instructions to the Owner's representatives for the electrical and specialized systems.
 2. If the Contractor does not have staff that can adequately provide the required instructions, the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.7 RECORD DOCUMENTS

- A. The following paragraphs supplement Division 1 requirements.
- B. Maintain at the job site a separate and complete set of electrical drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.

- C. Mark drawings and specifications to indicate approved substitutions; Change Orders, and actual equipment and materials used. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should this Contractor fail to complete Record Documents as required by this contract, this Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.
 - D. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.
 - E. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.
 - F. Record actual routing of conduits exceeding 2 inches.
- 3.8 PAINTING
- A. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available. All equipment shall have a finished coat of paint applied unless specifically allowed to be provided with a prime coat only.
 - B. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, the Contractor shall have the equipment and all its supports, hangers, etc., painted to match the room decor. Painting shall be performed as described in project specifications.
 - C. Equipment cabinets, casings, covers, metal jackets, etc., located in equipment rooms or concealed spaces, shall be furnished in standard finish, free from scratches, abrasions, chippings, etc.
 - D. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chipping, etc. If color option is specified or is standard to the unit, verify with the Architect the color preference before ordering.
 - E. All electrical conduit and equipment, fittings, hangers, structural supports, etc., in unfinished areas, such as equipment and storage room area, shall be painted two (2) coats of oil paint of colors selected by the Architect.
 - F. Do NOT paint electric conduits in crawl spaces, tunnels, or spaces above suspended ceilings except that where conduit is in a damp location give exposed threads at joints two coats of sealer after joint is made up.
 - G. In accordance with LEED EQc4.2: Low-Emitting Materials - Paints and Coatings, all paints and coatings used on the interior of the building must comply with the following criteria:
 - 1. Architectural paints and coatings applied to interior walls and ceilings must not exceed the volatile organic compound (VOC) content limits established in Green Seal Standard GS-11, Paints, 1st Edition, May 20, 1993.

2. Anti-corrosive and anti-rust paints applied to interior ferrous metal substrates must not exceed the VOC content limit of 250 g/L (2 lb./gal) established in Green Seal Standard GC-03, Anti-Corrosive Paints, 2nd Edition, January 7, 1997.

3.9 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.
- B. Clean all foreign paint, grease, oil, dirt, labels, stickers, etc. from all equipment.
- C. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.10 SPECIAL REQUIREMENTS

- A. Coordinate the installation of all equipment, controls, devices, etc., with other trades to maintain clear access area for servicing.
- B. Install all equipment to maximize access to parts needing service or maintenance. Review the final location, placement, and orientation of equipment with the Owner's representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's representative will result in removal and reinstallation of the equipment at the Contractor's expense.
- D. Adhesives and Sealants: All sealers, adhesives, and sealants shall comply with the low emitting material limits of the following standards:
 1. LEED - Low Emitting Materials - Adhesives and Sealants.

3.11 SYSTEM STARTING AND ADJUSTING

- A. The electrical systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes all calibration and adjustment of electrical controls, balancing of loads, troubleshooting and verification of software, and final adjustments that may be needed.
- B. Complete all manufacturer-recommended startup procedures and checklists to verify proper equipment operation and does not pose a danger to personnel or property.
- C. All operating conditions and control sequences shall be tested during the start-up period. Testing all interlocks, safety shut-downs, controls, and alarms.

- D. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.12 FIELD QUALITY CONTROL

A. General:

1. Conduct all tests required during and after construction. Submit test results in NETA format, or equivalent form, that shows the test equipment used, calibration date, tester's name, ambient test conditions, humidity, conductor length, and results corrected to 40°C.
2. Supply necessary instruments, meters, etc., for the tests. Supply competent technicians with training in the proper testing techniques.
3. All cables and wires shall be tested for shorts and grounds following installation and connection to devices. Replace shorted or grounded wires and cables.
4. Any wiring device, electrical apparatus or luminaire, if grounded or shorted on any integral "live" part, shall have all defective parts or materials replaced.
5. Test cable insulation of service and panel feeder conductors for proper insulation values. Tests shall include the cable, all splices, and all terminations. Each conductor shall be tested and shall test free of short circuits and grounds and have an insulation value not less than Electrical Code Standards. Take readings between conductors, and between conductors and ground.
6. If the results obtained in the tests are not satisfactory, make adjustments, replacements, and changes as needed. Then repeat the tests, and make additional tests, as the Architect/Engineer or authority having jurisdiction deems necessary.

B. Ground Resistance:

1. Conduct service ground resistance tests using an approved manufactured ground resistance meter. Submit to the Architect/Engineer a proposed test procedure including type of equipment to be used. (The conventional ohmmeter is not an acceptable device.)
2. Make ground resistance measurements during normal dry weather and not less than 48 hours after a rain.
3. If the ground resistance value obtained is more than the value set forth in Section 26 0526, the following shall be done to obtain the value given:
 - a. Verify that all connections in the service ground system are secure.
 - b. Increase the depth to which ground rods are driven by adding section lengths to the rods and retest. If the resistance is still excessive increase the depth by adding an additional rod section and retest.
 - c. If the resistance is still excessive, furnish and install additional ground rods, spaced not less than 20 feet from other ground rods unless otherwise noted on plans, and connect into the ground electrode system. Retest.
 - d. Review results with the Architect/Engineer.

4. Before final payment is made to the Contractor submit a written report to the Architect/Engineer including the following:
 - a. Date of test.
 - b. Number of hours since the last rain.
 - c. Soil condition at the time of the test in the ground electrode location. That is: dry, wet, moist, sand, clay, etc.
 - d. Diagram of the test set-up showing distances between test equipment, ground electrode, auxiliary electrodes, etc.
 - e. Make, model, and calibration date of test equipment.
 - f. Tabulation of measurements taken and calculations made.
- C. Ground-Fault Equipment Performance Testing:
1. Test: Perform ground-fault performance testing when system is installed. The test process shall use primary current injection per manufacturer instruction and procedures. Perform test for the following:
 - a. Service disconnects
 - b. Solid state molded case circuit breakers and solid-state insulated case circuit breakers equipped with ground fault protection.
 - c. Fusible switches with ground fault relay protection.
 - d. Outside branch circuits and feeders.
 - e. Code required.
 2. Report: Provide copy of test result report with Operation and Maintenance manuals. Provide report to Authority Having Jurisdiction when requested.
- D. Arc Energy Reduction Equipment Performance Testing:
1. Test: Perform arc energy protection performance testing when system is installed. The test process shall use primary current injection or approved method per manufacturer instructions and procedures. Perform test for the following:
 - a. All arc energy reduction systems installed.
 2. Report: Provide copy of test result report with Operation and Maintenance manuals. Provide report to Authority Having Jurisdiction when requested.
- E. Other Equipment:
1. Give other equipment furnished and installed by the Contractor all standard tests normally made to assure that the equipment is electrically sound, all connections properly made, phase rotation correct, fuses and thermal elements suitable for protection against overloads, voltage complies with equipment nameplate rating, and full load amperes are within equipment rating.
- F. If any test results are not satisfactory, make adjustments, replacements and changes as needed and repeat the tests and make additional tests as the Architect/Engineer or authority having jurisdiction deem necessary.

- G. Contractor shall thermographic study all electrical gear, switchboard, panelboards, etc. at the end of construction to identify any unusual conditions/heating within the equipment. Coordinate with Owner/Architect/Engineer to have an Owner/Architect/Engineer representative present during testing.
- H. Report shall include color printouts, in binder, of pictures taken to use as a baseline reading after building is occupied.
- I. Upon completion of the project, the Contractor shall provide amperage readings for all panelboards and switchboards and turn the results over to the Owner for "benchmark" amperages.

END OF SECTION

SECTION 26 0503 - THROUGH PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Through-Penetration Firestopping.

1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

1.3 REFERENCES

- A. UL 263 - Fire Tests of Building Construction and Materials
- B. UL 723 - Surface Burning Characteristics of Building Materials
- C. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
- D. UL 2079 - Tests for Fire Resistance of Building Joint Systems
- E. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
- F. Intertek / Warnock Hersey - Directory of Listed Products
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- H. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
- I. The Building Officials and Code Administrators National Building Code
- J. 2021 International Building Code
- K. NFPA 5000 - Building Construction Safety Code

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.
- B. Install material prior to expiration of product shelf life.

1.5 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
 2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
- B. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
- C. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- D. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

1.6 MEETINGS

- A. Pre-installation meeting: A pre-installation meeting shall be scheduled and shall include the General Contractor, all Subcontractors associated with the installation of systems penetrating fire barriers, Firestopping Manufacturer's Representative, and the Owner.
1. Review foreseeable methods related to firestopping work.
 2. Tour representative areas where firestopping is to be installed; inspect and discuss each type of condition and each type of substrate that will be encountered, and preparation to be performed by other trades.

1.7 WARRANTY

- A. Provide one year warranty on parts and labor.
- B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.

1. 3M; Fire Protection Products Division
2. Hilti, Inc.
3. RectorSeal Corporation, Metacaulk
4. Tremco; Sealant/Weatherproofing Division
5. Johns-Manville
6. Specified Technologies Inc. (S.T.I.)
7. Spec Seal Firestop Products
8. AD Firebarrier Protection Systems
9. Wiremold/Legrand: FlameStopper
10. Dow Corning Corp
11. Fire Trak Corp
12. International Protective Coating Corp

2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

- A. Provide materials and systems classified by or listed by Intertek / Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.
- B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.
- C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.
- D. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.
- E. Provide firestopping systems allowing continuous insulation for all insulated pipes.
- F. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.
- G. Any openings in floors or walls not described in the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory, or outlined in manufacturer's information shall be sealed in a manner agreed upon by the Firestopping Manufacturer, Owner, and the Authority Having Jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.
- B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.
- C. Surfaces to which sealing materials are to be installed must meet the selected UL or Intertek / Warnock Hersey system substrate criteria.
- D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

3.2 INSTALLATION

- A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Intertek / Warnock Hersey listed firestopping system is installed.
- B. Install penetration seal materials in accordance with printed instructions of the UL or Intertek / Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.
- C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

3.3 CLEANING AND PROTECTING

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

3.4 IDENTIFICATION

- A. Provide and install labels adjacent to each firestopping location. Label shall be provided by the firestop system supplier and contain the following information in a contrasting color:
 - 1. The words "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Firestop System Supplier; UL or listed by Intertek / Warnock Hersey system number; date installed; contractor name and phone number; manufacturer's representative name, address, and phone number.

3.5 INSPECTION

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.
- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.
- D. The contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the contractor and witnessed by the Architect/Engineer and manufacturer's factory representative. The Architect/Engineer shall have sole discretion of which firestop system installations will be reviewed. The contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the Architect/Engineer's discretion and the contractor's expense.

END OF SECTION

SECTION 26 0513 - WIRE AND CABLE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Building wire
- B. Cabling for remote control, signal, and power limited circuits

1.2 RELATED WORK

- A. Section 26 0553 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

PART 2 - PRODUCTS

2.1 BUILDING WIRE

- A. Feeders and Branch Circuits 8 AWG and larger: Copper, stranded conductor, 600-volt insulation, THHN/THWN or XHHW-2.
- B. Feeders and Branch Circuits 8 AWG and larger in Underground Conduit: Copper, stranded conductor, 600-volt insulation, XHHW-2.
- C. Feeders and Branch Circuits 10 AWG and Smaller: Copper, solid or stranded conductor, 600-volt insulation, THHN/THWN, unless otherwise noted on the drawings.
- D. Motor Feeder from Variable Frequency Drives: Copper conductor, 600-volt XHHW-2 insulation, stranded conductor, unless otherwise noted on the drawings.
- E. Control Circuits: Copper, stranded conductor 600-volt insulation, THHN/THWN.
- F. Each 120-volt branch circuit shall have a dedicated neutral conductor. Neutral conductors shall be considered current-carrying conductors for wire derating.

2.2 CABLING FOR REMOTE CONTROL, SIGNAL, AND POWER LIMITED CIRCUITS

- A. Wire for the following specialized systems shall be as designated on the drawings, or elsewhere in these specifications. If not designated on the drawings or specifications, the system manufacturer's recommendations shall be followed.
 - 1. Fire alarm
 - 2. Low voltage switching and lighting control

- B. Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a PVC jacket.
- C. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.
- D. Plenum Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a nonmetallic jacket; UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.

PART 3 - EXECUTION

3.1 WIRE AND CABLE INSTALLATION SCHEDULE

- A. All Locations: Building wire in raceway.
- B. Above Grade: All conductors installed above grade shall be type "THHN".
- C. Underground or In Slab: All conductors shall be type "THWN".
- D. Low Voltage Cable (less than 100 volts): Low voltage cables in ducts, plenums, and other air handling spaces shall be plenum listed. Low voltage cables in non-accessible areas shall be installed in conduit. Low voltage cable may be installed without conduit in accessible areas using the following types of cable supports. Cable support types/systems shall comply with the warranty requirements of the low voltage cable manufacturer.
 - 1. J-hooks

3.2 CONTRACTOR CHANGES

- A. The basis of design is copper conductors installed in raceway based on ambient temperature of 30°C, NEC Table 310.16 (2011 - 2017 edition 310.15(B)(16)).
- B. The Contractor shall be responsible for derating and sizing conductors and conduits to equal or exceed the ampacity of the basis of design circuits, if he/she chooses to use methods or materials other than the basis of design.
- C. Underground electrical duct ampacity rating shall be in accordance with NEC Table 310.16 (2011 - 2017 edition 310.15(B)(16)) or calculated in accordance with Annex B Application Information for Ampacity Calculation
- D. Record drawing shall include the calculations and sketches.

3.3 GENERAL WIRING METHODS

- A. Use no wire smaller than 12 AWG for power and lighting circuits, and no smaller than 14 AWG for control wiring.
- B. Use no wire smaller than 18 AWG for low voltage control wiring below 100 volts.
- C. Use 10 AWG conductor for 20 ampere, 120-volt branch circuit home runs longer than 75 feet, and for 20 ampere.
- D. Use no wire smaller than 8 AWG for outdoor lighting circuits.
- E. The ampacity of multiple conductors in one conduit shall be derated per the Electrical Code. In no case shall more than 4 conductors be installed in one conduit to such loads as motors larger than 1/4 HP, panelboards, motor control centers, etc.
- F. Where installing parallel feeders, place an equal number of conductors for each phase of a circuit in same raceway or cable.
- G. Splice only in junction or outlet boxes.
- H. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- I. Make conductor lengths for parallel circuits equal.
- J. All conductors shall be continuous in conduit from last outlet to their termination.
- K. Terminate all spare conductors on terminal blocks, and label the spare conductors.
- L. Cables or wires shall not be laid out on the ground before pulling.
- M. Cables or wires shall not be dragged over earth or paving.
- N. Care shall be taken so as not to subject the cable or wire to high mechanical stresses that would cause damage to the wire and cable.
- O. At least six (6)-inch loops or ends shall be left at each outlet for installation connection of luminaires or other devices.
- P. All wires in outlet boxes not connected to fixtures or other devices shall be rolled up, spliced if continuity of circuit is required, and insulated.

3.4 WIRING INSTALLATION IN RACEWAYS

- A. Pull all conductors into a raceway at the same time. Use UL listed wire pulling lubricant for pulling 4 AWG and larger wires. Do not use wire pulling lubricant for isolated (ungrounded) power system wiring.
- B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

- C. Pulling shall be continuous without unnecessary stops and starts with wire or cable only partially through raceway.
- D. Where reels of cable or wire are used, they shall be set up on jacks close to the point where the wire or cable enters the conduit or duct so that the cable or wire may be unreeled and run into the conduit or duct with a minimum of change in the direction of the bend.
- E. Conductors shall not be pulled through conduits until plastering or masonry work is completed and conduits are free from moisture. Care shall be taken so that long pulls of wire or pulls around several bends are not made where the wire may be permanently stretched and the insulation damaged.
- F. Only nylon rope shall be permitted to pull cables into conduit and ducts.
- G. Completely and thoroughly swab raceway system before installing conductors.
- H. Conductor Supports in Vertical Raceways:
 - 1. Support conductors in vertical raceways in accordance with the Electrical Code Spacing of Conductors Supports.
 - 2. Supports shall be of insulated wedge type (OZ Gedney Type S, or equal) and installed in a tapered insulated bushing fitting or a metal woven mesh with a support ring that fits inside conduit fitting installed in an accessible junction box (Hubbell Kellems support grip or equal).

3.5 CABLE INSTALLATION

- A. Provide protection for exposed cables where subject to damage.
- B. Use suitable cable fittings and connectors.
- C. Run all open cable parallel or perpendicular to walls, ceilings, and exposed structural members. Follow the routing as illustrated on the drawings as closely as possible. Cable routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatical, unless noted otherwise. The correct routing, when shown diagrammatically, shall be chosen by the Contractor based on information in the contract documents; in accordance with the manufacturer's written instructions, applicable codes, the NECA's "Standard of Installation", recognized industry standards; and coordinated with other contractors.
- D. Open cable shall be supported by the appropriate size J-hooks or other means if called for on the drawings. Wire and cable from different systems shall not be installed in the same J-hook. J-hooks shall be sized with 20% spare capacity. J-hooks shall provide proper bend radius support for data cable and fiber cables.
- E. Open cable installed above suspended ceilings shall not rest on the suspended ceiling construction, nor utilize the ceiling support system for wire and cable support.

- F. J-hook support spans shall be based on the smaller of the manufacturer's load ratings and code requirements. In no case shall horizontal spans exceed 5 feet and vertical spans exceed 4 feet. All J-hooks shall be installed where completely accessible and not blocked by piping, ductwork, inaccessible ceilings, etc. J-hooks shall be independently rigidly attached to a structural element. J-hooks shall be installed to provide 2" horizontal separation and 6" vertical separation between systems.
- G. Open cable shall only be installed where specifically shown on the drawings, or permitted in these specifications.

3.6 WIRING CONNECTIONS AND TERMINATIONS

- A. Splice and tap only in accessible junction boxes.
- B. Use solderless, tin-plated copper, compression terminals (lugs) applied with circumferential crimp for conductor terminations, 8 AWG and larger.
- C. Use solderless, tin-plated, compression terminals (lugs) applied with indenter crimp for copper conductor terminations, 10 AWG and smaller.
- D. Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and smaller. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps.
- E. Use compression connectors applied with circumferential crimp for conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor.
- F. Thoroughly clean wires before installing lugs and connectors.
- G. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.
- H. Phase Sequence: All apparatus shall be connected to operate in the phase sequence A-B-C representing the time sequence in which the phase conductors so identified reach positive maximum voltage.
- I. As a general rule, applicable to switches, circuit breakers, starters, panelboards, switchgear and the like, the connections to phase conductors are intended thus:
 - 1. Facing the front and operating side of the equipment, the phase identification shall be:
 - a. Left to Right - A-B-C
 - b. Top to Bottom - A-B-C
- J. Connection revisions as required to achieve correct rotation of motors shall be made at the load terminals of the starters or disconnect switches.
- K. Use antioxidant joint compound on all aluminum conductor terminations. Apply antioxidant joint compound per manufacturer's recommendations.

3.7 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Division 1.
- B. Building Wire and Power Cable Testing: Perform an insulation-resistance test on each conductor with respect to ground and adjacent conductors. Test shall be made by means of a low-resistance ohmmeter, such as a "Megger". The applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. The test duration shall be one minute. Insulation resistance must be greater than 100 mega-ohm for 600 volt and 25 mega-ohm for 300 volt rated cables per NETA Acceptance Testing Standard. Verify uniform resistance of parallel conductors.
- C. Inspect wire and cable for physical damage and proper connection.
- D. Torque test conductor connections and terminations to manufacturer's recommended values.
- E. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.
- F. Protection of wire and cable from foreign materials:
 - 1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any wire or cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited to, overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid, or compound that could come in contact with the cable, cable jacket, or cable termination components.
- G. Overspray of paint on any wire or cable will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed.

END OF SECTION

SECTION 26 0526 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Equipment grounding system
- B. Ground Bar

1.2 SUBMITTALS

- A. Product Data: For the following:
 - 1. Ground rods.

1.3 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.

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 Section 26 0513 "Wire and Cable".
- B. Material: Copper.
- C. Equipment Grounding Conductors: Insulated. Refer to Section 26 0553 for insulation color.
- D. Grounding Electrode Conductors: Stranded cable.
- E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.
- F. Copper Bonding Conductors: As follows:
 - 1. Bonding Conductor: No. 4 AWG, stranded copper conductor.
 - 2. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- G. FB; Grounding Bar
 - 1. Copper bar, 1/4" x 2" x 24". Provide with wall mounting brackets, insulators and pre-tapped holes.
 - 2. Manufacturers:

- a. Harger GBI Series.
- b. Erico EGB Series.

2.2 CONNECTOR PRODUCTS

- A. Comply with UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Connectors: Hydraulic compression type or Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.
- C. Bolted Connectors: Bolted-pressure-type connectors.

2.3 GROUNDING ELECTRODES

- A. Ground Rods Copper-clad steel.
- B. Concrete-Encased Grounding Electrode (Ufer): Fabricate according to Electrical Code, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG or 20 feet of 1/2" steel reinforcing bar.

PART 3 - EXECUTION

3.1 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.
 - 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. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. 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.
- D. 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.

- E. 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 non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- F. Structural Steel Connection: Exothermic-welded connections to structural steel. Coordinate with structure to provide physical protection.
- G. Underground Connections: Exothermic-welded connections.
- H. Connections at back boxes, junction boxes, pull boxes, and equipment terminations: The equipment grounding conductor(s) associated with all circuits in the box shall be connected together and to the box using a suitable grounding screw. The removal of the respective receptacle, luminaire, or other device served by the box shall not interrupt the grounding continuity.
- I. 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.
- 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.

3.2 INSTALLATION

- 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. Grounding Conductors: Route 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. Each grounding conductor that passes through a below grade wall must be provided with a waterstop.
- C. Grounding electrode conductor (GEC) shall be protected from physical damage by rigid polyvinyl chloride conduit (PVC) in exposed locations.
- D. In raceways, use insulated equipment grounding conductors.

3.3 EQUIPMENT GROUNDING SYSTEM

- A. Comply with Electrical Code, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by Electrical Code are indicated.
- B. Install equipment grounding conductors in all feeders and circuits. Terminate each end on a grounding lug or bus.

3.4 BONDING SYSTEM

- A. At building expansion joints, provide flexible bonding jumpers to connect to columns or beams on each side of the expansion joint.
- B. Isolated Equipment Enclosure: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment bonding conductor.
- C. Exterior Metallic Pull and Junction Box Covers, Metallic Hand Rails: Bond to grounding system using flexible grounding conductors.
- D. Water Heater, Heat-Tracing, Metal Well Casing, and Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and anti-frost heating cable. Bond conductor to heater units, piping, well casing, connected equipment, and components.
- E. Connect bonding conductors to metal water pipe using a suitable ground clamp. Make connections to flanged piping at street side of flange. Provide bonding jumper around water meter.
- F. Remote control, signaling, and fire alarm circuits shall be bonded in accordance with the most recent version of the National Electric Code.
- G. Metal Poles Supporting Outdoor Lighting Fixtures > 15 feet: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.

3.5 GROUNDING ELECTRODE SYSTEM

- A. Provide bonding at Utility Company's metering equipment and pad mounted transformer as required by utility company.
- B. Ground Rods: Install at least two rods spaced at least 20 feet from each other and located at least the same distance from other grounding electrodes.
 - 1. Drive ground rods until tops are 12 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.
- C. 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.
- D. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters, filtering devices, and similar equipment. Connect to pipe with grounding clamp connectors.

- E. Concrete-Encased Grounding Electrode (Ufer): Install concrete-encased grounding electrode encased in at least 2 inches of concrete horizontally within the foundation that is in contact with the earth. 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 below grade and connect to building grounding grid or to a grounding electrode external to concrete.

3.6 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
 - 1. Measure ground resistance from system neutral connection at service entrance to convenient ground reference points using suitable ground testing equipment. Resistance shall not exceed 5 ohms.
 - 2. Testing: Perform the following field quality-control testing:
 - a. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
 - b. 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.
 - c. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect/Engineer promptly and include recommendations to reduce ground resistance.

3.7 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 2. Maintain restored surfaces. Restore disturbed paving.

END OF SECTION

SECTION 26 0527 - SUPPORTING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Conduit and equipment supports
- B. Fastening hardware
- C. Concrete housekeeping pads

1.2 QUALITY ASSURANCE

- A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

1.3 COORDINATION

- A. Coordinate size, shape and location of concrete pads with section on Cast-in-Place Concrete or Concrete Topping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Allied Support Systems
- B. Cooper B-Line
- C. Erico, Inc.
- D. Hilti
- E. Power Fasteners
- F. Orbit Industries

2.2 MATERIAL

- A. Support Channel: Hot-dip galvanized for wet/damp locations; painted steel for interior/dry locations. All field cut ends shall be touched up with matching finish to inhibit rusting.
- B. Hardware: Corrosion resistant.
- C. Anchorage and Structural Attachment Components:

1. Strength: Defined in reports by ICBO Evaluation Service or another agency acceptable to Authorities Having Jurisdiction.
 - a. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.
2. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.
3. Welding Lugs: Comply with MSS-SP-69, Type 57.
4. Beam clamps for Steel Beams and Joists: Double sided or concentric open web joist hangars. Single-sided type is not acceptable.
5. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.
6. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.
7. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.
8. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

D. Conduit Sleeves and Lintels:

1. Each Contractor shall provide, to the General Contractor for installation, lintels for all openings required for the Contractor's work in masonry walls and conduit sleeves for floors, unless specifically shown as being by others.
2. Refer to Structural General Notes for lintel requirements in masonry construction.
3. Refer to Structural plans and specifications for lintel requirements and sizes.
4. Lintels:
 - a. Lintels in non-bearing masonry wall openings can be sized in accordance with the note below. Lintels that occur in existing bearing walls are to be sized according to similar conditions and spans in the new construction and lintel schedule. Bottom plate size shall be a minimum of 3/8" thick. The width of the plate shall be 3/4" less than the field verified wall thickness. The plate shall be the full length of the lintel member. Lintels are not required over openings that are 12" wide or less and at least 1 course below the top of the wall.
 - b. All lintels shall have a minimum of 8" end bearing.
 - c. All lintels in exterior wall construction shall be hot-dip galvanized.
 - d. For all openings not otherwise detailed or scheduled, minimum lintels shall be for each 4 inch of masonry width:
 - 1) 0 to 2'-0" span: 5/16" plate (3/4" less than wall width)
 - 2) 2'-0" to 4'-0" span: L 3 1/2 x 3 1/2 x 1/4
 - 3) 4'-0" to 6'-0" span: L4 x 3 1/2 x 5/16 (llv)
 - 4) 6'-0" to 8'-0" span: L5 x 3 1/2 x 5/16 (llv)

- e. All angles that are back to back shall be welded top and bottom 3" at 12" minimum.
5. Fabricate all lintels from structural steel shapes or as indicated on the drawings. All lintels and grouped wall openings shall be approved by the Architect or Structural Engineer.
 6. Fabricate all sleeves from standard weight black steel pipe. Provide continuous sleeve. Cut or split sleeves are not acceptable. Sleeves through concrete walls may be high density polyethylene pipe penetration sleeve with a water stop collar, suitable for use with Link-Seal mechanical seals. Century-Line Model CS.
 7. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
 8. Sleeves shall not penetrate structural members without approval from the Structural Engineer.
 9. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.
 10. Install all sleeves concentric with conduits. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
 11. Where conduits rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (asphalt and cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
 12. Size sleeves large enough to allow expansion and contraction movement.
- E. Concrete Housekeeping Pads:
1. Concrete bases for all floor mounted equipment and wall mounted equipment which is surface mounted and extends to within 6" of the finished floor, unless shown otherwise on the drawings, shall be 3-1/2" thick concrete.
 2. Bases shall extend 3" on all sides of the equipment (6" larger than factory base).
 3. Where the base is less than 12" from a wall, the base shall be carried to the wall to prevent a "dirt-trap".
 4. Concrete materials and workmanship required for the Contractor's work shall be provided by the Contractor. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6" x 6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at twenty-eight days.
- F. Rooftop Support System:
1. Provide pre-fabricated roof supports for all conduit and equipment installed above the roof. Support all conduit and equipment a minimum of 4" above roof.
 2. Support system shall be compatible with single ply, bituminous, metal, and spray foam roof systems. The base shall be rounded to prevent damage to the roof, and drainage holes shall prevent ponding of water in the support.
 3. All metal components shall be hot dipped galvanized. Mounting hardware shall be stainless steel or hot dipped galvanized. Support shall be UV, corrosion, and freeze/thaw resistant. Support shall include orange paint, reflective safety orange accents, or similar markings for increased visibility.
 4. Products:

- a. Anvil International HBS-Base Series
 - b. Cooper B-Line Dura-Blok
 - c. Erico Caddy Pyramid 50, 150, 300, or 600 (to match load).
- G. Truss and Joist Support System: Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:
1. Loads of 100 lbs. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.
 2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
 - a. The hanger is attached within 6" from a web/chord joint.
 - b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.
 3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
 4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using expansion anchors in concrete and beam clamps on structural steel.
- B. Trapeze support installation: Cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.
- C. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.
- D. Do not fasten supports to ceiling systems, piping, ductwork, mechanical equipment, or conduit, unless otherwise noted.
- E. Do not use powder-actuated anchors without specific permission.
- F. Do not drill structural steel members.
- G. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.
- H. In wet locations and on all building floors below exterior earth grade install free-standing electrical equipment on concrete pads.

- I. Install cabinets and panelboards with minimum of four anchors. Provide horizontal backing/support framing in stud walls for rigid mounting.
 - J. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.
 - K. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
 - L. Refer to Section 26 0533 for special conduit supporting requirements.
- 3.2 FINISH
- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.
 - B. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

END OF SECTION

SECTION 26 0533 - CONDUIT AND BOXES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Rigid metallic conduit and fittings (RMC)
- B. Intermediate metallic conduit and fittings (IMC)
- C. Electrical metallic tubing and fittings (EMT)
- D. Flexible metallic conduit and fittings (FMC)
- E. Liquidtight flexible metallic conduit and fittings (LFMC)
- F. Rigid polyvinyl chloride conduit and fittings (PVC)
- G. High density polyethylene conduit and fittings (HDPE)
- H. Reinforced thermosetting resin conduit (RTRC)
- I. Wall and ceiling outlet boxes
- J. Electrical connection
- K. Pull and junction boxes
- L. Handholes
- M. Accessories

1.2 RELATED WORK

- A. Section 26 0553 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.3 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated
 - 2. ANSI C80.3 - Electrical Metallic Tubing, Zinc-Coated and Fittings
 - 3. ANSI C80.4 - Fittings for Rigid Metal Conduit and Electrical Metallic Tubing
 - 4. ANSI C80.6 - Intermediate Metal Conduit, Zinc Coated
 - 5. ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports
- B. Federal Specifications (FS):

1. A-A-50553A - Fittings for Conduit, Metal, Rigid, (Thick-Wall and Thin-Wall (EMT) Type
 2. A-A-55810 - Specification for Flexible Metal Conduit
- C. NECA "Standards of Installation"
- D. National Electrical Manufacturers Association (NEMA):
1. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
 2. RN 1 - Polyvinyl chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit, Rigid Aluminum Conduit, and Intermediate Metal Conduit
 3. TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit
 4. TC 9 - Fittings for PVC Plastic Utilities Duct for Underground Installation
- E. NFPA 70 - National Electrical Code (NEC)
- F. Underwriters Laboratories (UL): Applicable Listings
1. UL 1 - Flexible Metal Conduit
 2. UL 6 - Rigid Metal Conduit
 3. UL 360 - Liquid Tight Flexible Steel Conduit
 4. UL514-B - Conduit Tubing and Cable Fittings
 5. UL651-A - Type EB and a PVC Conduit and HDPE Conduit
 6. UL651-B - Continuous Length HDPE Conduit
 7. UL797 - Electrical Metal Tubing
 8. UL1242 - Intermediate Metal Conduit
- G. American Standard of Testing and Materials (ASTM):
1. ASTM D 570 - Standard Test Method for Water Absorption of Plastics
 2. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics
 3. ASTM D 648 - Standard Test Method for Deflection Temperature of Plastics under Flexural Load in the Edge Wise Position
 4. ASTM D 2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
 5. ASTM D 2447 - Standard Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter
 6. ASTM D 3350 - Standard Specification for Polyethylene Plastic Pipe and Fittings Material
- H. Definitions:
1. Fittings: Conduit connection or coupling.
 2. Body: Enlarged fittings with opening allowing access to the conductors for pulling purposes only.
 3. Mechanical Spaces: Enclosed areas, usually kept separated from the general public, where the primary use is to house service equipment and to route services. These spaces generally have exposed structures, bare concrete and non-architecturally emphasized finishes.
 4. Finished Spaces: Enclosed areas where the primary use is to house personnel and the general public. These spaces generally have architecturally emphasized finishes, ceilings and/or floors.

5. Concealed: Not visible by the general public. Often indicates a location either above the ceiling, in the walls, in or beneath the floor slab, in column coverings, or in the ceiling construction.
6. Above Grade: Not directly in contact with the earth. For example, an interior wall located at an elevation below the finished grade shall be considered above grade but a wall retaining earth shall be considered below grade.
7. Slab: Horizontal pour of concrete used for a floor or sub-floor.

PART 2 - PRODUCTS

2.1 RIGID METALLIC CONDUIT (RMC) AND FITTINGS

A. Manufacturers:

1. Allied
2. LTV
3. Steelduct
4. Calbond Calpipe
5. Wheatland Tube Co
6. O-Z Gedney

B. Manufacturers of RMC Conduit Fittings:

1. Appleton Electric
2. O-Z/Gedney Co.
3. Electroline
4. Raco
5. Bridgeport
6. Midwest
7. Regal
8. Thomas & Betts
9. Crouse-Hinds
10. Killark
11. Orbit Industries

C. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted.

D. Fittings and Conduit Bodies:

1. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
2. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.
3. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.

4. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. High impact phenolic threaded type bushings are not acceptable.
5. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.

2.2 INTERMEDIATE METALLIC CONDUIT (IMC) AND FITTINGS

A. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted.

B. Manufacturers:

1. Allied
2. LTV
3. Steelduct
4. Wheatland Tube Co
5. O-Z Gedney

C. Fittings and Conduit Bodies:

1. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
2. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.
3. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.
4. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. High impact phenolic threaded type bushings are not acceptable.
5. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.

2.3 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

A. Minimum Size Electrical Metallic Tubing: 3/4 inch, unless otherwise noted.

B. Manufacturers of EMT Conduit:

1. Allied
2. Calbond Calpipe
3. LTV
4. Steelduct
5. Wheatland Tube Co

C. Fittings and Conduit Bodies:

1. 2" Diameter or Smaller: Compression type of steel designed for their specific application.

2. 1/2" and 3/4" Conduit: Push-on connectors and couplers with locking ring and washer of zinc plated steel, listed for use in dry locations.
3. Larger than 2": Compression type of steel designed for their specific application.
4. Manufacturers of EMT Conduit Fittings:
 - a. Appleton Electric
 - b. O-Z/Gedney Co.
 - c. Electroline
 - d. Raco
 - e. Bridgeport
 - f. Midwest
 - g. Regal
 - h. Thomas & Betts
 - i. Orbit Industries

2.4 FLEXIBLE METALLIC CONDUIT (FMC) AND FITTINGS

- A. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted. Lighting branch circuit wiring to an individual luminaire may be a manufactured, UL listed 3/8" flexible metal conduit and fittings with #14 AWG THHN conductors and an insulated ground wire. Maximum length of 3/8" FMC shall be six (6) feet.
- B. Manufacturers:
 1. American Flex
 2. Alflex
 3. Electri-Flex Co
- C. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel. Provide a separate equipment grounding conductor when used for equipment where flexibility is required.
- D. Fittings and Conduit Bodies:
 1. Threadless hinged clamp type, galvanized zinc coated cadmium plated malleable cast iron or screw-in type, die-cast zinc.
 2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.
 3. Manufacturers:
 - a. O-Z/Gedney Co.
 - b. Thomas & Betts
 - c. Appleton Electric
 - d. Electroline
 - e. Bridgeport
 - f. Midwest
 - g. Regal
 - h. Orbit Industries

2.5 LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT (LFMC) AND FITTINGS

A. Manufacturers:

1. Anaconda Type UA
2. Electri-Flex Type LA
3. Alflex
4. Carlon (Lamson & Sessions)

B. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel and an extruded PVC cover.

C. Fittings and Conduit Bodies:

1. Watertight, compression type, galvanized zinc coated cadmium plated malleable cast iron, UL listed.
2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.
3. Manufacturers:
 - a. Appleton Electric
 - b. O-Z/Gedney Co.
 - c. Electroline
 - d. Bridgeport
 - e. Thomas & Betts
 - f. Midwest
 - g. Regal
 - h. Carlon (Lamson & Sessions)
 - i. Orbit Industries

2.6 RIGID NON-METALLIC CONDUIT (PVC) AND FITTINGS

A. Minimum Size Rigid Smooth-Wall Nonmetallic Conduit: 3/4 inch, unless otherwise noted.

B. Acceptable Manufacturers:

1. Carlon (Lamson & Sessions) Type 40
2. Cantex, J.M. Mfg.

C. Construction: Schedule 40 and Schedule 80 rigid polyvinyl chloride (PVC), UL labeled for 90°C.

D. Fittings and Conduit Bodies: NEMA TC 3; sleeve type suitable for and manufactured especially for use with the conduit by the conduit manufacturer.

E. Plastic cement for joining conduit and fittings shall be provided as recommended by the manufacturer.

2.7 HIGH DENSITY POLYETHYLENE (HDPE)

- A. Minimum Size: 2 inch, unless noted otherwise.
- B. Acceptable Manufacturers:
 - 1. Carlon
 - 2. Chevron Phillips Chemical Company
- C. Materials used for the manufacture of polyethylene pipe and fittings shall be extra high molecular weight, high-density polyethylene resin. The material shall be listed by PPI (Plastic Pipe Institute) and shall meet the following resin properties:

ASTM Test	Description	Values HDPE
D-1505	Density g/CM 3	less than 0.941
D-1238	Melt Index, g/10 min Condition E	greater than 0.55 grams/10 min.
D-638	Tensile Strength at yield (psi)	3000 min.
D-1693	Environmental Stress Crack Resistance Condition B, F 20	96 hrs.
D-790	Flexural Modulus, MPa (psi)	less than 80,000
D-746	Brittleness Temperature	-75°C Max

- D. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same raw material, including both the base resin and coextruded resin. The pipe shall be homogeneous throughout and free of visible cracks, holes, voids, foreign inclusions, or other defects that may affect the wall integrity.
- E. Fitting and Conduit Bodies:
 - 1. Directional Bore and Plow Type Installation: Electrofusion or Universal Aluminum threaded couplings. Tensile strength of coupled pipe must be greater than 2,000 lbs.
 - 2. For all other type of installation: Coupler must provide a water tight connection. The tensile strength of coupled pipe must be greater than 1,000 lbs.
 - 3. E-loc type couplings are not acceptable in any situations.
 - 4. Acceptable Manufacturers:
 - a. ARCON
 - b. Carlon

2.8 REINFORCED THERMOSETTING RESIN CONDUIT (RTRC) AND FITTINGS

- A. Minimum Size: 1 inch.
- B. Acceptable Manufacturers:
 - 1. Champion Fiberglass
 - 2. FRE Composites
 - 3. or approved equal.

- C. Conduit shall be fiberglass reinforced epoxy using a filament winding process. Conduit, elbows and fittings shall be manufactured from the same resin/hardener/glass system and the same filament wound system. Resin systems shall be epoxy with no fillers. Glass used shall be E-type.
- D. Fitting and Conduit Bodies:
 - 1. Expansion fittings for RTRC shall be provided in accordance with Electrical Code.
 - 2. Joints in wet locations and underground locations shall be watertight.

2.9 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1; galvanized steel, 16 gauge (approximately 0.0625 inches), with 1/2-inch male fixture studs where required.
- B. Cast Boxes: NEMA FB1, Type FD, Aluminum, cast ferrous alloy, or stainless steel deep type, gasketed cover, threaded hubs.
- C. Outlet boxes for luminaires to be not less than 1-1/2" deep, deeper if required by the number of wires or construction. The box shall be coordinated with surface luminaires to conceal the box from view or provide a finished trim plate.
- D. Switch outlet boxes for local light control switches, dimmers and occupancy sensors shall be 4 inches square by 2-1/8 inches deep, with raised cover to fit flush with finish wall line. Multiple gang switch outlets shall consist of the required number of gang boxes appropriate to the quantity of switches comprising the gang. Where walls are plastered, provide a plaster raised cover. Where switch outlet boxes occur in exposed concrete block walls, boxes shall be installed in the block cavity with a raised square edge tile cover of sufficient depth to extend out to face of block or masonry boxes.
- E. Outlet boxes for telephone substations in walls and columns shall be 4 inches square and 2-1/8 inches deep with single gang raised cover to fit flush with finished wall line equipped with flush telephone plate.
- F. Wall or column receptacle outlet boxes shall be 4 inches square with raised cover to fit flush with finished wall line. Boxes in concrete block walls shall be installed the same as for switch boxes in block walls.

2.10 ECONN; ELECTRICAL CONNECTION

- A. Electrical connection to equipment and motors, sized per Electrical Code. Coordinate requirements with contractor furnishing equipment or motor. Refer to specifications and general installation notes for terminations to motors.

2.11 JB; PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes: ANSI/NEMA OS 1; galvanized steel.
- B. Sheet metal boxes larger than 12 inches in any dimension that contain terminations or components: Continuous hinged enclosure with 1/4 turn latch and white back panel for mounting terminal blocks and electrical components.

- C. Cast Metal Boxes for Outdoor and Wet Location Installations: NEMA 250; Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight. Galvanized cast iron box and cover with ground flange, neoprene gasket, and stainless steel cover screws.
- D. Flanged type boxes shall be used where installed flush in wall.

2.12 HANDHOLES

- A. HH-1; Handhole, composite polymer concrete body and cover. Stainless steel hardware. Bolted non-skid cover rated for 5,000 pounds. Design load occasional non-deliberate vehicular traffic. Stack units to achieve depth shown on plans. Units in landscaped areas shall be green in color. 11"W, 18"L, 18"D.
 - 1. Manufacturers:
 - a. Hubbell/Quazite PG
 - b. Carson Industries H Series
 - c. Armorcast
 - d. Highline Products
 - e. Synertech

2.13 ACCESSORIES

- A. Sound Barrier Insulation Pads: Mastic, non-hardening, sheet material, minimum 1/8" thickness applied to all five sides of back boxes. Kinetics Noise Control - SealTight Backer Pad, L.H. DOTTIE Co., #68 or equal.

PART 3 - EXECUTION

3.1 CONDUIT INSTALLATION SCHEDULE AND SIZING

- A. In the event the location of conduit installation represents conflicting installation requirements as specified in the following schedule, a clarification shall be obtained from the Architect/Engineer. If this Contractor is unable to obtain a clarification as outlined above, concealed rigid galvanized steel conduit installed per these specifications and the Electrical Code shall be required.
- B. Dry, interior locations: RMC, IMC, EMT, FMC
- C. Exterior or wet locations: RMC, IMC, LFMC
- D. Below slab on grade: PVC
- E. Below grade outside of building: PVC, RTRC, HDPE

- F. Size conduit as shown on the drawings and specifications. Where not indicated in the contract documents, conduit size shall be according to the Electrical Code. Conduit and conductor sizing shall be coordinated to limit conductor fill to less than 40%, maintain conductor ampere capacity as required by the Electrical Code (to include enlarged conductors due to temperature and quantity derating values) and to prevent excessive voltage drop and pulling tension due to long conduit/conductor lengths.
- G. Minimum Conduit Size (Unless Noted Otherwise):
 - 1. Above Grade: 3/4 inch. (The use of 1/2 inch would be allowed for installation conduit to individual light switches, individual receptacles and individual fixture whips from junction box.)
 - 2. Below Grade 5' or less from Building Foundation: 3/4 inch.
 - 3. Below Grade More than 5' from Building Foundation: 1 inch.
 - 4. Telecommunication Conduit: 1 inch.
- H. Conduit Embedded in Slabs above Grade: NOT allowed.
- I. Conduit sizes shall change only at the entrance or exit to a junction box, unless specifically noted on the drawings.

3.2 CONDUIT ARRANGEMENT

- A. In general, conduit shall be installed concealed in walls, in finished spaces and where possible or practical, or as noted otherwise. Conduit shall be installed parallel or perpendicular to walls, ceilings, and exposed structural members. In unfinished spaces, mechanical and utility areas, conduit may run either concealed or exposed as conditions dictate and as practical unless noted otherwise on drawings. Installation shall maintain headroom in exposed vicinities of pedestrian or vehicular traffic.
- B. Exposed conduit on exterior walls or above roof will not be allowed without prior written approval of Architect/Engineer. A drawing of the proposed routing and a photo of the location shall be submitted 14 days prior to start of conduit rough-in. Routing shall be shown on coordination drawings.
- C. Conduit shall not share the same cell as structural reinforcement in masonry walls.
- D. Conduit runs shall be routed as shown on large scale drawings. Conduit routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatic, unless noted otherwise. The correct routing, when shown diagrammatically shall be chosen by the Contractor based on information in the contract documents, in accordance with manufacturer's written instructions, applicable codes, the NECA's "Standard of Installation", in accordance with recognized industry standards, and coordinated with other contractors.
- E. Contractor shall adapt Contractor's work to the job conditions and make such changes as required and permitted by the Architect/Engineer, such as moving to clear beams and joists, adjusting at columns, avoiding interference with windows, etc., to permit the proper installation of other mechanical and/or electrical equipment.

- F. Contractor shall cooperate with all contractors on the project. Contractor shall obtain details of other contractor's work to ensure fit and avoid conflict. Any expense due to the failure of This Contractor to do so shall be paid for in full by Contractor. The other trades involved as directed by the Architect/Engineer shall perform the repair of work damaged as a result of neglect or error by This Contractor. The resultant costs shall be borne by This Contractor.

3.3 CONDUIT SUPPORT

- A. Conduit runs installed above a suspended ceiling shall be properly supported. In no case shall conduit rest on the suspended ceiling construction, nor utilize ceiling support system for conduit support.
- B. Conduit shall not be supported from ductwork, water, sprinkler piping, or other non-structural members, unless approved by the Architect/Engineer. All supports shall be from structural slabs, walls, structural members, and bar joists, and coordinated with all other applicable contractors, unless noted otherwise.
- C. Conduit shall be held in place by the correct size of galvanized one-hole conduit clamps, two-hole conduit straps, patented support devices, clamp back conduit hangers, or by other means if called for on the drawings.
- D. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- E. Spring-steel conduit clips specifically designed for supporting single conduits or tubing may be used in lieu of malleable-iron hangers for 1" and smaller raceways serving lighting and receptacle branch circuits above accessible ceilings and for securing raceways to slotted channel and angle supports.
- F. Group conduits in parallel runs where practical and use conduit racks or trapeze hangers constructed of steel channel, suspended with threaded solid rods or wall mounted from metal channels with conduit straps or clamps. Provide space in each rack or trapeze for 25% additional conduits.
- G. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- I. Supports for metallic conduit shall be no greater than 10 feet. A smaller interval may be used if necessitated by building construction, but in no event shall support spans exceed the Electrical Code requirements. Conduit shall be securely fastened within 3 feet of each outlet box, junction box, device box, cabinet, or fitting.
- J. Supports of flexible conduit shall be within 12 inches of each outlet box, junction box, device box, cabinet, or fitting and at intervals not to exceed 4.5 feet.

- K. Supports for non-metallic conduit shall be at sufficiently close intervals to eliminate any sag in the conduit. The manufacturer's recommendations shall be followed, but in no event shall support spans exceed the Electrical Code requirements.
- L. Where conduit is to be installed in poured concrete floors or walls, provide concrete-tight conduit inserts securely fastened to forms to prevent conduit misplacement.
- M. Finish:
 - 1. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.
 - 2. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

3.4 CONDUIT INSTALLATION

A. Conduit Connections:

- 1. Shorter than standard conduit lengths shall be cut square using industry standards. The ends of all conduits cut shall be reamed or otherwise finished to remove all rough edges.
- 2. Metallic conduit connections in slab on grade installation shall be sealed and one coat of rust inhibitor primer applied after the connection is made.
- 3. Where conduits with tapered threads cannot be coupled with standard couplings, then approved split or Erickson couplings shall be used. Running threads will not be permitted.
- 4. Install expansion/deflection joints where conduit crosses structure expansion/seismic joints.

B. Conduit terminations for all low voltage wiring shall have nylon bushings installed on each end of every conduit run.

C. Conduit Bends:

- 1. Use a hydraulic one-shot conduit bender or factory elbows for bends in conduit 2" in size or larger. All steel conduit bending shall be done cold; no heating of steel conduit shall be permitted.
- 2. All bends of rigid polyvinyl chloride conduit (PVC) shall be made with the manufacturer's approved bending equipment. The use of spot heating devices will not be permitted (i.e. blow torches).
- 3. A run of conduit shall not contain more than the equivalent of four (4) quarter bends (360°), including those bends located immediately at the outlet or body.
- 4. Telecommunications conduits shall have no more than two (2) 90-degree bends between pull points and contain no continuous sections longer than 100 feet. Insert pull points or pull boxes for conduits exceeding 100 feet in length.
 - a. A third bend is acceptable if:
 - 1) The total run is not longer than (33) feet.
 - 2) The conduit size is increased to the next trade size.

5. Telecommunications pull boxes shall not be used in lieu of a bend. Align conduits that enter the pull box from opposite ends with each other. Pull box size shall be twelve (12) times the diameter of the largest conduit. Slip sleeves or gutters can be used in place of a pull box.
6. Telecommunications Conduit(s): Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of less than 2", maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter 2" or greater, maintain a bend radius of at least 10 times the internal diameter.
7. Rigid polyvinyl chloride conduit (PVC) runs longer than 100 feet or runs which have more than two 90° equivalent bends (regardless of length) shall use rigid metal or RTRC factory elbows for bends.
8. Use conduit bodies to make sharp changes in direction (i.e. around beams).

D. Conduit Placement:

1. Conduit shall be mechanically continuous from source of current to all outlets. Conduit shall be electrically continuous from source of current to all outlets, unless a properly sized grounding conductor is routed within the conduit. All metallic conduits shall be bonded per the Electrical Code.
2. Route exposed conduit and conduit above suspended ceilings (accessible or not) parallel/perpendicular to the building structural lines, and as close to building structure as possible. Wherever possible, route horizontal conduit runs above water and steam piping.
3. Route conduit through roof openings provided for piping and ductwork where possible. If not provided or routing through provided openings is not possible, route through roof jack with pitch pocket. Coordinate roof penetrations with other trades.
4. Conduits, raceway, and boxes shall not be installed in concealed locations in metal deck roofing or less than 1.5" below bottom of roof decking.
5. Avoid moisture traps where possible. Where unavoidable, provide a junction box with drain fitting at conduit low point.
6. All conduits through walls shall be grouted or sealed into openings. Where conduit penetrates firewalls and floors, seal with a UL listed sealant. ; refer to Section 26 0503 for through penetration firestopping requirements.
7. **CONTRACTOR SHALL BE RESPONSIBLE FOR ALL OPENINGS REQUIRED IN MASONRY OR EXTERIOR WALLS UNDER THIS DIVISION. A QUALIFIED MASON AT THE EXPENSE OF THIS CONTRACTOR SHALL REPAIR ALL OPENINGS TO MATCH EXISTING CONDITIONS.**
8. Seal interior of conduit at exterior entries, air handling units, coolers/freezers, etc., and where the temperature differential can potentially be greater than 20°F, to prevent moisture penetration. Seal shall be placed where conduit enters warm space. Conduit seal fitting shall be a drain/seal, with sealing compound, identified for use with cable and raceway system, equal to O-Z/Gedney type EYD.
9. Horizontal conduit routing through slabs above grade.
 - a. Conduits, if run in concrete structure, shall be in middle one-third of slab thickness, and leave at least 3" min. concrete cover. Conduits shall run parallel to each other and spaced at least 8" apart centerline to centerline. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement. Maximum conduit outside diameter 1".
 - b. No conduits are allowed in concrete on metal deck unless expressly approved in writing by the Structural Engineer.

- c. No conduits are allowed to be routed horizontally through slabs above grade.
- 10. Do not route conduits across each other in slabs on grade.
- 11. Rigid polyvinyl chloride conduit (PVC) shall be installed when material surface temperatures and ambient temperature are greater than 40°F.
- 12. Where rigid polyvinyl chloride conduit (PVC) is used below grade, in a slab, below a slab, etc., a transition to rigid galvanized steel or PVC-coated steel conduit shall be installed before conduit exits earth. The metallic conduit shall extend a minimum of 6" into the surface concealing the non-metallic conduit.
- 13. Contractor shall provide suitable mechanical protection around all conduits stubbed out from floors, walls or ceilings during construction to prevent bending or damaging of stubs due to carelessness with construction equipment.
- 14. Contractor shall provide a polypropylene pull cord with 2000 lbs. tensile strength in each empty conduit (indoor and outdoor), except in sleeves and nipples.

3.5 CONDUIT TERMINATIONS

- A. Where conduit bonding is indicated or required in the contract documents, the bushings shall be a grounding type sized for the conduit and ground bonding conductor as manufactured by O-Z/Gedney, Appleton, Thomas & Betts, Burndy, Regal, Orbit Industries or approved equal.
- B. Conduits with termination fittings shall be threaded for one (1) lock nut on the outside and one (1) lock nut and bushing on the inside of each box.
- C. Where conduits terminate in boxes with knockouts, they shall be secured to the boxes with lock nuts and provided with approved screw type tinned iron bushings or fittings with plastic inserts.
- D. Where conduits terminate in boxes, fittings, or bodies with threaded openings, they shall be tightly screwed against the shoulder portion of the threaded openings.
- E. Conduit terminations to all motors shall be made with flexible metallic conduit (FMC), unless noted otherwise. Final connections to roof exhaust fans, or other exterior motors and motors in damp or wet locations shall be made with liquidtight flexible metallic conduit (LFMC). Motors in hazardous areas, as defined in the Electrical Code, shall be connected using flexible conduit rated for the environment. Flexible conduit shall not exceed 6' in length. Route equipment ground conductors from circuit ground to motor ground terminal through flexible conduit.
- F. Rigid polyvinyl chloride conduit (PVC) shall be terminated using fittings and bodies produced by the manufacturer of the conduit, unless noted otherwise. Prepare conduit as per manufacturer's recommendations before joining. All joints shall be solvent welded by applying full even coat of plastic cement to the entire areas that will be joined. Turn the conduit at least a quarter to one half turn in the fitting and let the joint cure for 1-hour minimum or as per the manufacturer's recommendations.
- G. All conduit ends shall be sealed with plastic immediately after installation to prevent the entrance of any foreign matter during construction. The seals shall be removed and the conduits blown clear of all foreign matter prior to any wires or pull cords being installed.

3.6 UNDERGROUND CONDUIT INSTALLATION

A. Conduit Connections:

1. Conduit joints in a multiple conduit run shall be staggered at least one foot apart.

B. Conduit Bends (Lateral):

1. Conduits shall have long sweep radius elbows instead of standard elbows wherever special bends are indicated and noted on the drawings, or as required by the manufacturer of the equipment or system being served.
2. Telecommunications conduit bend radius shall be six times the diameter for conduits under 2" and ten times the diameter for conduits over 2". Where long cable runs are involved, sidewall pressures may require larger radius bends. Coordinate with Architect/Engineer prior to conduit installation to determine bend radius.

C. Conduit Elbows (vertical):

1. Minimum metal or RTRC elbow radiuses shall be 30 inches for primary conduits (greater than 600V) and 18 inches for secondary conduits (less than 600V). Increase radius, as required, based on pulling tension calculation requirements.

D. Conduit Placement:

1. Conduit runs shall be pitched a minimum of 4" per 100 feet to drain toward the terminations. Duct runs shall be installed deeper than the minimum wherever required to avoid any conflicts with existing or new piping, tunnels, etc.
2. For parallel runs, use suitable separators and chairs installed not greater than 4' on centers. Band conduit together with suitable banding devices. Securely anchor conduit to prevent movement during concrete placement or backfilling.
3. Where concrete is required, the materials for concreting shall be thoroughly mixed to a minimum $f'c = 2500$ and immediately placed in the trench around the conduits. No concrete that has been allowed to partially set shall be used.
4. Before the Contractor pulls any cables into the conduit, Contractor shall have a mandrel 1/4" smaller than the conduit inside diameter pulled through each conduit and if any concrete or obstructions are found, the Contractor shall remove them and clear the conduit. Spare conduit shall also be cleared of all obstructions.
5. Conduit terminations in manholes, masonry pull boxes, or masonry walls shall be with malleable iron end bell fittings.
6. All spare conduits not terminated in a covered enclosure shall have its terminations plugged as described above.
7. Ductbanks and conduit shall be installed a minimum of 24" below finished grade, unless otherwise noted on the drawings or elsewhere in these specifications.
8. All non-metallic conduit installed underground outside of a slab shall be rigid.

E. Horizontal Directional Drilling:

1. Entire drill path shall be accurately surveyed, with entry and exit stakes placed and coordinated with other contractors. If using a magnetic guidance system, entire drill path shall be surveyed for any surface geo-magnetic variations or anomalies.

2. Any utility locates within 20 feet of the bore path shall have the exact location physically verified by hand digging or vacuum excavation. Restore inspection holes to original condition after verification.

F. Raceway Seal:

1. Where a raceway enters a building or structure, it shall be sealed with a sealing bushing or duct seal to prevent the entry of liquids or gases. Seal must be compatible with conductors and raceway system. Spare or unused raceway shall also be sealed.
2. All telecommunications conduits and innerducts, including those containing cables, shall be plugged at the building and vault with "JackMoon" or equivalent duct seal, capable of withstanding a 10-foot head of water (5 PSI).

3.7 BOX INSTALLATION SCHEDULE

A. Galvanized steel boxes may be used in:

1. Concealed interior locations above ceilings and in hollow studded partitions.
2. Exposed interior locations in mechanical rooms and in rooms without ceilings; higher than 8' above the highest platform level.
3. Direct contact with concrete except slab on grade.
4. Recessed in stud wall of kitchens and laundries.

B. Cast boxes shall be used in:

1. Exterior locations.
2. Hazardous locations.
3. Exposed interior locations within 8' of the highest platform level.
4. Direct contact with earth.
5. Direct contact with concrete in slab on grade.
6. Wet locations.
7. Kitchens and laundries when exposed on wall surface.

3.8 COORDINATION OF BOX LOCATIONS

- A. Provide electrical boxes as shown on the drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.
- B. Electrical box locations shown on the Contract Drawings are approximate, unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough-in.
- C. Locate and install boxes to allow access. Avoid interferences with ductwork, piping, structure, equipment, etc. Recessed luminaires shall not be used as access to outlet, pull, and junction boxes. Where installation is inaccessible, provide access doors. Coordinate locations and sizes of required access doors with the Architect/Engineer and General Contractor.
- D. Locate and install to maintain headroom and to present a neat appearance.
- E. Coordinate locations with Heating Contractor to avoid baseboard radiation cabinets.

3.9 OUTLET BOX INSTALLATION

- A. Do not install boxes back-to-back in walls.
 - 1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls. When the minimum separation cannot be maintained, install sound insulation pads on all five sides of the back box in accordance with the manufacturer's instructions.
 - 2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, the box is greater than 16 square inches or the total box area (all trades) per 100 square feet is greater than or equal to 100 square inches, install fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.
- B. Install sound insulation pads on all five sides of the back of all boxes in sound-rated wall assemblies. Sound-rated wall assemblies are defined as partition types carrying a Sound Transmission Class (STC) rating.
- C. The Contractor shall anchor switch and outlet box to wall construction so that it is flush with the finished masonry, paneling, drywall, plaster, etc. The Contractor shall check the boxes as the finish wall surface is being installed to assure that the box is flush. (Provide plaster rings as necessary.)
- D. Mount at heights shown or noted on the drawings or as generally accepted if not specifically noted.
- E. Locate boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for boxes.
- F. Provide knockout closures for unused openings.
- G. Support boxes independently of conduit.
- H. Use multiple-gang boxes where more than one device is mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.
- I. Install boxes in walls without damaging wall insulation.
- J. Coordinate mounting heights and locations of outlets mounted above counters, benches, backsplashes, and below baseboard radiation.
- K. Position outlets to locate luminaires as shown on reflected ceiling drawings.
- L. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioned to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.

- M. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.
- N. Provide cast outlet boxes in exterior locations and wet locations, and where exposed rigid or intermediate conduit is used.

3.10 PULL AND JUNCTION BOX INSTALLATION

- A. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.
- B. Support pull and junction boxes independent of conduit.
- C. Do not install boxes back-to-back in walls.
 - 1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls. When the minimum separation cannot be maintained, install sound insulation pads on all five sides of the back box in accordance with the manufacturer's instructions.
 - 2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, the box is greater than 16 square inches or the total box area (all trades) per 100 square feet is greater than or equal to 100 square inches, install fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.
- D. Install sound insulation pads on all five sides of the back of all boxes in sound-rated wall assemblies. Sound-rated wall assemblies are defined as partition types carrying a Sound Transmission Class (STC) rating.

3.11 EXPOSED BOX INSTALLATION

- A. Boxes shall be secured to the building structure with proper size screws, bolts, hanger rods, or structural steel elements.
- B. On brick, block and concrete walls or ceilings, exposed boxes shall be supported with no less than two (2) Ackerman-Johnson, Paine, Phillips, or approved equal screw anchors or expansion shields and round head machine screws. Cast boxes shall not be drilled.
- C. On steel structures, exposed boxes shall be supported to the steel member by drilling and tapping the member and fastening the boxes by means of round head machine screws.
- D. Boxes may be supported on steel members by APPROVED beam clamps if conduit is supported by beam clamps.
- E. Boxes shall be fastened to wood structures by means of a minimum of two (2) wood screws adequately large and long to properly support. (Quantity depends on size of box.)
- F. Wood, plastic, or fiber plugs shall not be used for fastenings.
- G. Explosive devices shall not be used unless specifically allowed.

City of Evanston
Evanston Animal Shelter
Holabird & Root, LLC Project No. 16015

Issued for Bid / Permit
12/08/2022

END OF SECTION

SECTION 26 0553 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Adhesive Markings and Field Labels
- B. Nameplates and Signs
- C. Product Colors

PART 2 - PRODUCTS

2.1 ADHESIVE MARKINGS AND FIELD LABELS

- A. Adhesive Marking Labels for Raceway: Pre-printed, flexible, self-adhesive vinyl labels with legend indicating voltage and service (Emergency, Lighting, Power, HVAC, Communications, Control, Fire).
 - 1. Label Size as follows:
 - a. Raceways: Kroy or Brother labels 1-inch high by 12-inches long (minimum).
 - 2. Color: As specified for various systems.
- B. Colored Adhesive Marking Tape for banding Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.
- C. Pretensioned Flexible Wraparound Colored Plastic Sleeves for Cable Identification: flexible acrylic bands sized to suit the cable diameter and arranged to stay in place by pre-tensioned gripping action when coiled around the cable.
- D. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.
- E. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from -40°F to 185°F (-40°C to 85°C), type 2/2S or type 21/21S based on application. Provide ties in specified colors when used for color coding. Cable ties shall be listed and identified for the application, securement, and support.
- F. Underground Plastic Markers: Bright colored continuously printed plastic ribbon tape of not less than 6 inches wide by 4 mil thick, printed legend indicating type of underground line, manufactured for direct burial service. Tape shall contain a continuous metallic wire to allow location with a metal detector.

- G. Aluminum, Wraparound Marker Bands: 1-inch width, 0.014 (5mm) inch thick aluminum bands with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.
- H. Brass or Aluminum Tags: 2" (50mm) by 2" (50mm) by .05-inch metal tags with stamped legend, punched for fastener.
- I. Indoor/Outdoor Number and Letters: Outdoor grade vinyl label with acrylic adhesive designed for permanent application in severe indoor and outdoor environments.
- J. Text Sizes:
 - 1. The following information shall be used for text heights, fonts, and size, unless otherwise noted.
 - a. Font: Normal 721 Swiss Bold
 - b. Adhesive Labels: 3/16 inch minimum text height
 - c. Vinyl / Plastic Laminate Labels: 3/4" inch minimum text height

2.2 NAMEPLATES AND SIGNS

- A. Engraved, Plastic-Laminated Labels, Signs and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger sizes. Labels shall be punched for mechanical fasteners.
- B. Baked-Enamel Signs for interior Use: Preprinted aluminum signs, punched, or drilled for fasteners, with colors, legend, and size required for application. Mounting 1/4" grommets in corners.
- C. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396 inch galvanized-steel backing: and with colors, legend, and size required for application. Mounting 1/4" grommets in corners.
- D. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.
- E. Fasteners for Plastic-Laminated Signs; Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.

2.3 PRODUCT COLORS

- A. Adhesive Markings and Field Labels:
 - 1. All Labels: Black letters on white or clear face
- B. Nameplates and Signs:
 - 1. NORMAL POWER: Black letters on white face
- C. Raceways and Conduit:

1. Provide color coded conduit as indicated below. Conduit shall be colored by the manufacturer:
 - a. Normal Power and General Distribution: Silver
 - b. Fire Alarm System: Red
 - c. Temperature Controls: Refer to mechanical cover sheet for color
 - d. Ground: Green
 - e. Low Voltage and Telephone: Purple

- D. Box Covers:
 1. Box cover colors shall match conduit colors listed above.

- E. Conductor Color Identification: Refer to Part 3 for additional information.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as required by code.

- B. Exposed Ceilings and Finished Spaces: The project includes exposed ceilings in finished spaces. The installation of colored raceways and labeling may not be aesthetically desirable in finished spaces. The contractor shall coordinate identification requirements in exposed ceilings of finished spaces with the A/E prior to installation and ordering of materials.

- C. Electrical System Color Chart: This Contractor shall furnish and install framed 8" x 12" charts of the color-coded identification scheme used for the electrical system in all electrical rooms and next to the main fire alarm panel.

- D. Install identification devices in accordance with manufacturer's written instruction and requirements of Electrical Code.

- E. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work. All mounting surfaces shall be cleaned and degreased prior to identification installation.

- F. Circuit Identification: Tag or label conductors as follows:
 1. Multiple Power or Lighting Circuits in Same Enclosure: Where multiple branch circuits are terminated or spliced in a box or enclosure, label each conductor with source and circuit number.
 2. Multiple Control Wiring and Communication/Signal Circuits in Same Enclosure: For control and communications/signal wiring, use wire/cable marking tape at terminations in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tape.

3. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.
- G. Apply warning, caution and instruction signs as follows:
1. Install warning, caution or instruction signs where required by Electrical Code, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
 2. Emergency Operating Signs: Install, where required by Electrical Code, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect, engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
- H. Apply circuit/control/item designation labels of engraved plastic laminate for pushbuttons, pilot lights, alarm/signal components, and similar items, except where labeling is specified elsewhere.
- I. Install labels parallel to equipment lines at locations as required and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- J. Install ARC FLASH WARNING signs on all switchboards.
1. Sample Label:

! WARNING
ARC FLASH AND SHOCK HAZARD
APPROPRIATE PPE REQUIRED
FAILURE TO COMPLY CAN RESULT IN DEATH OR INJURY
REFER TO NFPA 70E
- K. Underground Electrical Lines: For exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 (150mm) to 8 (205mm) inches below grade. A single plastic line marker is permitted when the width of the common trench does not exceed 16 inches; provide a second plastic line marker to mark each edge of the trench when 16 inches of width is exceeded. Install line marker for underground wiring, both direct-buried cables and cables in raceway.
- 3.2 RECEPTACLE COVER PLATES
- A. Identification material to be a clear, 3/8-inch Kroy tape or Brother self-laminating vinyl label with black letters. Embossed Dymo-Tape labels are not acceptable. Permanently affix identification label to cover plates, centered above the receptacle openings.
 - B. Identification material to be engraved plastic-laminated labels, 1/16-inch minimum thickness with white letters on a red face. Letter and number size to 1/8-inch high.

- C. Identification to be engraved directly on the stainless steel coverplates. Letter and number size to 1/8-inch high.
- D. Provide identification on all switch and receptacle cover plates. Identification shall indicate source and circuit number serving the device (e.g. "C1A #24"). Identification for switch cover plates shall be installed on the inside cover.

3.3 BOX LABELING

- A. Identify Junction, Pull and Connection Boxes: Labeling shall be 3/8-inch Kroy tape OR Brother self-laminating vinyl label, letters/numbers. In rooms that are painted out, provide labeling on inside of cover.
- B. All junction, pull, and connection boxes shall be identified as follows:
 - 1. For power and lighting circuits, indicate system voltage and identity of contained circuits ("120V, 1LA1-3,5,7").
 - 2. Essential Electrical System EES: When applicable the label shall include "Essential Electrical System EES". Maximum interval between label intervals shall be 25 feet or as required by code.
 - 3. For other wiring, indicate system type and description of wiring ("FIRE ALARM NAC #1").

3.4 CONDUCTOR COLOR CODING

- A. Products:
 - 1. All wire and cables shall be color coded by the manufacturer.
 - 2. All wires and cables, 6 AWG or larger, used in motor circuits, main feeders, sub-main feeders, and branch circuits shall be coded by the application of plastic tape. The tape shall be 3-M, Plymouth or Permacel in colors specified below. The tape shall be applied at each conductor termination with two 1-inch tape bands at 6-inch centers. Contractor option to use colored cabling in lieu of the tape at each end for conductor 6 AWG to 500 KCM.
- B. Color coding shall be applied at all panels, switches, junction boxes, pull boxes, vaults, manholes etc., where the wires and cables are visible and terminations are made. The same color coding shall be used throughout the entire electrical system, therefore maintaining proper phasing throughout the entire project.
- C. Colored cable ties shall be applied in groups of three ties of specified color to each conductor at each terminal or splice point starting 3 inches from the termination and spaced at 3- inches centers. Tighten to a snug fit, and cut off excess length.
- D. Where more than one nominal voltage system exists in a building or facility, each ungrounded conductor of a multi-wire branch circuit, where accessible, shall be identified by phase and system.
- E. Conductors shall be color coded as follows:
 - 1. 208Y/120 Volt, 4-Wire:

- a. A-Phase - Black
 - b. B-Phase - Red
 - c. C-Phase - Blue
 - d. Neutral - White
 - e. Ground Bond - Green
2. Grounding Conductors:
- a. Equipment grounding conductors, main/system/supply-side bonding jumpers: Green.
3. Cabling for Remote Control, Signal, and Power Limited Circuits:
- a. Fire Alarm: Red.
 - b. Low Voltage Switching: Per manufacturer recommendations and code requirements.
 - c. Audio/Visual Systems: Refer to Division 27.
 - d. Structured Cabling: Refer to Division 27.

3.5 CONTROL EQUIPMENT IDENTIFICATION

- A. Provide identification on the front of all control equipment such as starters, etc.
- B. Labeling shall include:
1. Equipment type and contract documents designation of equipment being served.
 2. Location of equipment being served if it is not located within sight.
 3. Voltage and phase of circuit(s).
 4. Panel and circuit number(s) serving the equipment.
 5. Sample Label:

EXHAUST FAN EF-1 ("LOCATED ON ROOF")
480V, 3-PHASE
FED FROM "1HA1-1"

3.6 EQUIPMENT CONNECTION IDENTIFICATION

- A. Provide identification for hard wired electrical connections to equipment such as disconnects switches, starters, etc. Plug and cord type connections do not require this specific label.
- B. Identification shall be provided for all connections to equipment furnished by this Contractor, other contractors, or the Owner.
- C. Labeling shall include:
1. Equipment type and contract documents designation of equipment being served
 2. Location of equipment being served if it is not located within sight.
 3. Voltage and rating of the equipment.
 4. Panel and circuit numbers(s) serving the equipment

5. Sample Label:

UNIT HEATER UH-1 ("LOCATED IN STORAGE ROOM 200")
480V: 3-PHASE
FED FROM "1HA1-1"

3.7 POWER DISTRIBUTION EQUIPMENT IDENTIFICATION

A. Provide identification on the front of all power distribution equipment such as panelboards, switchboards, switchgear, motor control centers, generators, UPS, storage battery disconnects, transfer switches, etc. Labels shall be visible on the exterior of the gear, correspond to the one-line diagram nomenclature, and identify each cubicle of multi-section gear.

1. Interior Equipment: The identification material shall be engraved plastic-laminated labels.
2. Exterior Equipment: The identification material shall be engraved vinyl labels.
3. Labeling shall include:

- a. Equipment type and contract documents designation of equipment.
- b. Voltage of the equipment.
- c. Name of the upstream equipment and location of the upstream equipment if it is not located within sight.
- d. Rating and type of the overcurrent protection device serving the equipment if it is not located within sight ("FED BY 400A/3P BREAKER").
- e. Sample Label:

DISTRIBUTION PANEL DP-H1
480Y/277V
FED FROM SWITCHBOARD "SB-1" (LOCATED IN MAIN ELEC ROOM)

B. Arc Energy Reduction Label:

1. Provide a separate engraved plastic laminate label centered at the top of each vertical section of the electrical gear indicating the following when applicable.

- a. Label: "This equipment is designed with a system listed below".
- b. Applicable Systems:

- 1) Arc energy reducing maintenance switch

C. Distribution panelboards and switchboards shall have each overcurrent protection device identified with name and location of the load being served ("AHU-1 LOCATED IN PENTHOUSE 1"). Provide a separate engraved plastic laminate label adjacent to each overcurrent projection device.

D. Branch panelboards shall be provided with typed panel schedules upon completion of the project. A copy of all panel schedules for the project shall be turned over as part of the O&M Manuals. Refer to Section 26 0500 for other requirements.

3.8 POLE IDENTIFICATION

A. Product:

1. Adhesive labels and field markings
2. Nameplates and signs

B. Lighting poles, bollards and overhead distribution poles shall be individually identified with a unique number, for maintenance purposes. Apply the vinyl label number above the hand hole cover or 24" (610mm) above grade. Bollards may be identified with a number applied inside the luminaire that is visible from the exterior.

END OF SECTION

SECTION 260800 - COMMISSIONING OF ELECTRICAL

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. Section includes commissioning process requirements for ELECTRICAL systems, assemblies, and equipment.
- B. Provide documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel. Work with the Commissioning Authority and in cooperation with other members of the commissioning team to ensure compliance.
- C. Refer to Section 019113 GENERAL COMMISSIONING REQUIREMENTS for commissioning requirements.
- D. Related Sections:
 - 1. Division 01 Section "General Commissioning Requirements" for commissioning process requirements.

1.3 COMMISSIONING

- A. This section governs the commissioning of Electrical systems.
- B. The following systems and equipment shall be commissioned (*), where applicable.
 - 1. Lighting and Lighting System Controls

(*) The above list is not intended to be all-inclusive, but rather a representative summary of the scope of Commissioning services to be provided for Electrical categories.

- C. Refer to Division 01. Section 019113, "General Commissioning Requirements" for the Work related to commissioning of these systems.

PART 2 - PRODUCTS: NOT USED

PART 3 - EXECUTION: NOT USED

END OF SECTION 260800

SECTION 26 0913 - POWER MONITORING AND CONTROL SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Power monitoring and control system is defined to include, but is not limited to, remote devices for monitoring communication interface hardware, inter-communications wiring, network software, printer, and personal computer workstations.

1.2 RELATED SECTIONS AND WORK

- A. Refer to the Riser Diagram for rating, location and configuration.

1.3 QUALITY ASSURANCE

- A. Manufacturer: Company with three (3) years of experience in power measurements and controls.

1.4 REFERENCES

- A. ANSI C12 - Code for Electrical Metering
- B. ANSI C57.13 - Requirements for Instrument Transformers

1.5 SUBMITTALS

- A. Provide product data showing the type, size, rating, catalog number, manufacturer's names, and/or data sheets for all items to ensure compliance with these specifications. Submit operation and programming manual.
- B. Submit shop drawings of the complete layout of the entire system, showing wiring and all equipment.

1.6 REGULATORY REQUIREMENTS

- A. System: UL listed.

1.7 SYSTEM DESCRIPTION

- A. The power monitoring and controls (PMCS) shall consist of electronic power monitoring devices as designated on the project drawings and described herein. The system shall be capable of monitoring, displaying, logging, and communicating the true RMS measurements in this specification as a minimum level of performance. The system shall be designed so the maximum response time from an event or reading to displaying shall be 10 seconds.
- B. Minimum accuracy of readings shall be:

1. Frequency \pm 0.01 Hz.
2. Current and voltage \pm 0.5% of reading.
3. Energy \pm 1% of reading.

1.8 PROJECT RECORD DOCUMENTS

- A. Provide installation and maintenance manuals under provisions of Section 26 0500.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Square D - POWERLOGIC and ION Enterprise
- B. Eaton Power Xpert
- C. Siemens

2.2 POWER MONITORING NETWORK

- A. The PMCS shall be connected by means of an Ethernet high-speed backbone. The high-speed network shall consist of gateways, switches, patch cords, backbone cabling, and any required equipment.
- B. Ethernet gateways or communications cards shall be provided and installed by the PMCS vendor as required. Ethernet network connections shall be established using industry standard Ethernet protocol, such as TCP/IP.
- C. Patch Cords: Cat 6; color to be determined by the Owner.
- D. Wireless Ethernet and interface hardware shall be provided and installed by the PMCS vendor in Electrical Code classified areas.
- E. Ethernet Gateways:
 1. The Ethernet gateways shall be modular in design to allow for easy future expansion or modification of the system. Ethernet gateway shall support Ethernet UTP (10/100 Mbps). Each Ethernet gateway shall provide a web-based interface for device configuration, diagnostics, and access for users to power monitoring information from any location on a local area network (LAN) or wide area network (WAN).
- F. The PMCS shall be connected by mean of the facilities Ethernet backbone. Provide Ethernet gateway or communication cards as required to connect system to network jacks installed as part of the facility's Ethernet network. Network connections shall be established using industry standard Ethernet protocol, such as TCP/IP. All components shall work with facility's Ethernet switches, router, and hub technology.

2.3 INTERFACE TO EXTERNAL SYSTEMS

- A. The high-speed network utilized by the PMCS system shall permit easy interface with the Facilities Management and Control System (FMCS).
- B. Data located in the power monitoring devices and PLC registers and associated inputs/outputs shall be made available to the FMCS vendor via meters and/or programmable controller register lists. Hardware and software required by the FMCS to retrieve this data from the PMCS data highway shall be the responsibility of the FMCS vendor.

2.4 PMCS APPLICATION SOFTWARE

- A. The PMCS manufacturer shall supply application software that provides the operator access to all meter data, systems reports, breaker/contactor/switch status communication alarms, captured waveforms and logged data.
- B. All software shall be configured by the vendor and delivered ready to use. The configuration shall include preparation of all required graphics, displays, and interactive one-line diagrams. When additional devices are added in the future, the user shall be able to add the communication address and device type, and the software shall automatically display all data from the device in a format identical to that used by existing devices of the same type.
- C. In addition to the PMCS application software programs, each PC shall permit the use of other Windows-based programs as desired by the user.
- D. Application software shall be supplied to support system configuration, monitoring of the devices, data logging, alarming, and other operations associated with the PMCS. The software provided shall include the following software option(s):
 - 1. System Monitoring (multiple devices at a time):
 - a. Application designed to monitor the entire system of power monitoring devices in the background for alarms, events, and data logging, allowing the operator to perform other tasks with the workstation.
 - b. Display information from the PMCS in a variety of standard formats, including real time data and trend displays, historical reports, graphical displays with real-time data updates, support of .pdf, .doc, .txt, .html, .htm, .xls and .ppt file formats.
 - c. Log PMCS data to printer and hard disk at user-specified intervals and provide exporting functions to allow usage of the logged data by other software products.
 - d. Color-coded alarms for digital quantities and analog quantities, each with user-selectable indication including visual, audible, and/or required acknowledgment. Additionally, multi-level alarms shall be supported for analog quantities.
 - e. Events shall be recorded in an Event Log file with a minimum storage capacity of 1000 events, the date/time of the event, and a descriptive text.
 - f. Report the status of metering devices inputs and outputs.
 - g. Password protected resets accumulated real, accumulated reactive energy, energy management alarms, minimum and maximums, and other circuit quantities associated with the power monitoring devices.

- h. Graphical waveform displays for the voltages, phase currents, and residual current monitored by metering devices.

2.5 PMCS APPLICATION REPORTS

- A. Capable of custom report creation. Standard report templates shall include historical tables and trends, energy profile, cost allocation, power factor and alarm analysis.
- B. Graphical views of historical trending shall support both pan and zoom. All standard metering parameters shall be logged, including minimum, maximum, and average.
- C. Reports shall be generated on demand or as a scheduled task to run automatically at specified intervals.
- D. Shall have the ability to view data from different devices on the same trend plot simultaneously.
- E. Shall have the ability to filter end user access to reports based on user name/login.
- F. Provide graphical waveform displays for the phase voltages, phase currents, and residual currents monitored by meters. Additional displays shall include overlay of three (3) phases of voltage, three (3) phases of current, and each phase voltage and current overlaid.

2.6 SOFTWARE SERVICE AGREEMENT

- A. The electrical equipment manufacturer shall include a three (3) year Software Service Agreement, which provides the customer with software upgrades for the software specified above as they are available.

2.7 POWER MONITORING DEVICES INSTALLATION

- A. All metering devices, shall be installed by the equipment manufacturer for all circuits as indicated by the project drawings.
- B. All control power, CT, PT, and data communications wire shall be factory wired and harnessed within the equipment enclosure. Where external circuit connections are required, terminal blocks shall be provided, and the manufacturer's drawings must clearly identify the interconnection requirements, including wire type to be used.
- C. Provide control transformers, current transformers, and fused potential transformers sized as required.

2.8 POWER MONITORING DEVICE CHARACTERISTICS

- A. DPM/PM; Power Meter:
 - 1. The following instantaneous readings shall be monitored, displayed, and communicated by the power meter:
 - a. Frequency, monthly maximum and minimum

- b. Current, per phase RMS, 3-phase average RMS, apparent RMS, peak demand (15-minute sliding window)
 - c. Voltage, phase-to-phase and phase-to-neutral
 - d. Power factor, per phase and 3-phase total
 - e. Real power (kW), 3-phase total, peak demand, cumulative (kWH)
2. The current and voltage signals shall be digitally sampled at a rate high enough to provide true-RMS sensing through the 31st harmonic. All setup parameters required by the power meter shall be stored in nonvolatile memory and retained in the event of a control power interruption. The meter shall maintain, in nonvolatile memory, maximum and minimum values for each of the instantaneous values reported, as well as the time and date of the highest peak for all peak demand readings.
3. The power meter shall be equipped with a display to provide local access to all metered quantities.
4. Reset of the following electrical parameters shall also be allowed from the front of the display or energy meter:
 - a. Peak demand current
 - b. Peak demand power
 - c. Energy (MWH)
5. Waveform Capture Capability: Waveform capture shall be for three (3) cycles and initiated manually using software.
6. The data points shall be sampled in a manner that allows the original power signals with proper magnitude and phase relationships to be reconstructed. Reconstruction of the original power signal from the stored data points shall have sufficient accuracy to allow steady-state power harmonic analysis that provides valid information on harmonic content for up to the 81st harmonic of the fundamental power frequency.
7. The power meter shall have one (1) digital input and one (1) digital solid state output/KY pulse output.
8. The power meter shall be provided with a six (6) digital input and two (2) digital output (relay) output accessory card.
9. Manufacturers:
 - a. Square D Power Logic
 - b. Eaton
 - c. Siemens

2.9 SYSTEM DISPLAY UNITS

- A. System display units shall be provided to display the data available from selected electronic trip units connected on the individual data transfer network.
- B. The system display unit shall utilize a 4 line by 20 character, high contrast display with backlighting. The level of backlighting as well as the contrast shall be adjustable.
- C. The system display shall be equipped with a screen saver feature to extend the life of the display.

- D. Data shall be displayed in a logically organized manner, complete with the proper scaling and units.
- E. The system display unit shall allow for easy operation by providing a keypad with large keys for operator selections. The keys shall have a raised perimeter and tactile feedback to provide a positive response, even with gloved-hand operation.
- F. The keys shall be clearly marked to indicate the function and separated into meaningful groups, with display prompting to assist the user in operation.
- G. Each system display unit shall be configured by the manufacturer with all necessary data. It shall be possible to change the configuration for each system display unit using the keypad provided on each display. Access to configuration functions shall be password protected to prevent unauthorized or accidental modification.
- H. The system display unit shall permit the reset of the stored min-max values in the power monitoring devices. It shall also permit the reset of the accumulated energy values and the time and date stamps stored in the metering devices. These resets shall be limited to authorized persons by means of password protection.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. PMCS components, including system display units, metering devices,, shall be installed by the manufacturer, and wired and tested in the equipment as indicated on the drawings. All control power, CT, PT, and data communications wire shall be factory wired and harnessed within the equipment enclosure.
- B. Where external circuit connections are required, terminal blocks shall be provided and the manufacturer's drawings must clearly identify the interconnection requirements, including wire type to be used.
- C. All wiring required to externally connect equipment lineups shall be installed by the Electrical Contractor.

3.2 STARTUP AND TRAINING

- A. Onsite startup and training of the PMCS shall be included in the project bid. Startup shall include a complete working demonstration of the PMCS, with simulation of possible operating conditions that may be encountered.
- B. Training shall include any documentation and hands-on exercises necessary to enable electrical operations personnel to assume full operating responsibility for the PMCS after completion of the training period.
- C. The project bid shall include two (2) days startup assistance and three (3) days training to include two training sessions, with the second training session being two (2) months after occupancy.

- D. The power monitoring manufacturer shall provide a full-time telephone technical help center for customers.

END OF SECTION

SECTION 26 0933 - LIGHTING CONTROL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Lighting Controls

1.2 RELATED SECTIONS

- A. The lighting system design includes a combination of luminaire sources, lighting control components, programming sequences, and supplementary components for building and energy code compliance. The design uses performance-based specifications for portions of the lighting system to account for the limitation of comparable product solutions available by competitive manufacturers. The Contractor shall reference related specification sections, plans, schedules, and details prior to submitting pricing, submittals, and installation. The Contractor shall coordinate system component compatibility among various manufacturers and suppliers for a turnkey lighting system. Referenced sections include, but are not limited to, the following:

- 1.
2. Electrical Drawings: Plans, luminaire schedules, lighting control sequence of operations, diagrams, and details.

1.3 REFERENCES

- A. FS W S 896 Switch, Toggle
- B. NEMA WD 1 - General Color Requirements for Wiring Devices
- C. NEMA WD 7 - Occupancy Motion Sensors
- D. NFPA 70 - National Electrical Code (NEC)

1.4 SUBMITTALS

- A. Submit a comprehensive package including devices, hardware, software, product specification, finishes, dimensions, installation instructions, warranty, system software requirements, and roles and responsibilities of all persons and groups involved in installation, execution, and commissioning.
- B. Provide floor plan showing location, orientation, and coverage area of each control device, sensor, and controller/interface. For areas requiring multiple sensor devices for appropriate coverage, submit specific manufacturer-approved sensor layout as an overlay directly on the project drawings, either in print or approved electronic form.

- C. Submit project specific control wiring diagrams showing all equipment, line voltage, and control wiring requirements for all components including, but not limited to, dimmers, relays, low voltage switches, occupancy sensors, control stations, dimmer panels, relay panels, and communication interfaces and programming instructions for each sequence of operation. Include network cable specification and end-of-line termination details, if required.

1.5 PROJECT RECORD DOCUMENTS

- A. Accurately record location of all controls and devices. Include description of switching sequences and circuiting arrangements.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit emergency, operation, and maintenance data under provisions of Section 26 0500. Data shall also include the following:
 - 1. Complete narrative describing intended operation and sequence for each control scenario and system component, updated to reflect all changes resulting from commissioning of systems. Narrative shall indicate recommended settings for devices where applicable.
 - 2. Replacement part numbers for all system components.
- B. Submit software operating and maintenance manuals, program software backup on compact disc or compatible media with data files, device address list, and a printout of software application and graphic screens, where applicable.

1.7 SYSTEM DESCRIPTION

- A. Performance Statement: This specification section and the accompanying lighting design documents describe the minimum material quality, required features, and operational requirements of the lighting control system (LCS). These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the performance required of the system, as presented in these documents, the Contractor and system manufacturer/vendor are solely responsible for determining all equipment, wiring, and programming required for a complete and operational system.
- B. Provide an integrated lighting controls system consisting of panels, power supplies, controllers, sensors, relays, switches, devices, wiring, etc. necessary to perform the Lighting Control Sequence of Operation as defined on the plans and specifications. Contractor is responsible for confirming that all components and luminaires interoperate as a single system.
 - 1. Sequence of Operation: Describes the required operation and performance for lighting control in each space. Sequences of operation are indicated on the drawings.
 - 2. Drawings: The drawings include sequences of operation, locations of control interface devices, sensors, and control zones. Wiring and additional equipment to make a complete and functioning system has not been shown, but shall be submitted with the shop drawings.
- C. The following control types and features are acceptable. Acceptable control locations are shown on the drawings.

1. Line Voltage Control: Control equipment consists of traditional line voltage wiring devices and equipment such as switches, dimmers and combination occupancy/vacancy sensor switches, etc.
2. Low Voltage Control: Control equipment is in the space/zone being controlled; Standalone and centralized controllers.
 - a. All locations shall have the ability to be networked for remote control and monitoring.

1.8 WARRANTY

- A. Manufacturer shall warrant products under normal use and service to be free from defects in materials and workmanship for a period of two (2) years from date of commissioning.
- B. Occupancy, vacancy, daylight sensors and controls shall have a five (5) year warranty from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL LIGHTING CONTROLS

- A. All items of material having a similar function (e.g., switches, dimmers, sensors, contactors, relays, etc.) shall be of the same manufacturer, unless specifically stated otherwise on drawings or elsewhere in the specifications. Lighting control switches, systems, and components shall be listed.
- B. Color of lighting controls and sensors shall match the receptacle wiring devices specified in the space.
- C. The functions described in the lighting sequence of operation shall dictate the actual lighting control device required to accomplish the functions described for the space.
- D. Basis of Design Controls Manufacturer: AcuityBrands

2.2 LOW VOLTAGE CONTROLS

- A. [WC]: Wall Control Interface
 1. Wall control interface to provide all control functions indicated in the Sequence of Operation.
 2. Wall control interface shall consist of an ON/OFF switch for each switching zone and an ON/OFF switch + Raise/Lower for each dimming zone indicated on the drawings.
 3. Dimming controls shall match the protocol and be compatible with the controlled luminaires.
- B. [LCP]: Lighting Control Panel

1. Central station shall provide programmable operation of lights connected via system relays and controlled with system devices. System software shall provide control of relays and control devices, time and sequence scheduling, timed out and blink light operation, and monitoring and reporting of system events and components. Initial programming shall be as shown on plans and schedules.
- C. [SW-OC-P-V]: Wall Switch Occupancy/Vacancy Sensor:
1. Dual technology using passive infrared and ultrasonic or acoustic detection methods, zero crossing circuitry, adjustable sensitivity and time delay, no minimum load requirements.
 - a. "V" symbol on drawings indicates "Vacancy" sensor with manual on operation.
 - b. "O" symbol on drawings indicated "Occupancy" sensor with automatic on operation.
- D. [SW-OC-D]: Occupancy/Vacancy Sensor Dual-Technology Type:
1. Ceiling mount, 360 degree coverage pattern, 28-foot radial walking motion coverage, dual technology passive infrared and acoustic, low voltage, adjustable time delay (1 to 30 minutes), adjustable sensitivity.
 - a. VS symbol on drawings indicates "Vacancy" sensor with manual on operation.
 - b. OC symbol on drawings indicated "Occupancy" sensor with automatic on operation.
- E. [SW-LS]: Daylight Level Sensor - Dimming:
1. Ceiling mount, closed loop, 24VDC low voltage, automatic set-point calculation, range of 1-300 FC, adjustable deadband prevents cycling, adjustable time delay.
 2. 0-10 volt current sink controller for control of LED drivers.
 3. Provide all 0-10 volt control wiring to controlled LED drivers.
- F. LINE VOLTAGE SWITCHES
- G. Refer to Electrical Symbols List for device type.

* * * antimicrobial for health care * * define locations where used * * *

SPECIFIER: Paragraph below is not typical for all projects. Edit to suit project.

- H. [SW-1P]: Single Pole Switch:
1. Single throw, 120/277-volt, 20-amp maintained contact. Toggle handle, side and back wired.
 2. Manufacturers:
 - a. Hubbell HBL1221
 - b. Leviton 1221-2
 - c. Pass & Seymour PS20AC1
 - d. Cooper AH1221

* * * * * OR DECORATOR style * * * * *

I. [SW-VS]: Wall Switch Dimming Vacancy Sensor:

1. Dual technology using passive infrared and ultrasonic or acoustic detection methods, zero crossing circuitry, adjustable sensitivity and time delay, no minimum load requirements.
2. Compatible with 0-10V dimming luminaires.
3. Manufacturers:
 - a. Sensor Switch
 - b. Hubbell
 - c. Leviton
 - d. Cooper

2.3 CONDUCTORS AND CABLES

A. Control Wiring:

1. Where installed with the line-voltage wiring, control wiring shall be copper conductors not smaller than No. 16 AWG with insulation voltage rating and temperature rating equal to that of the line-voltage wiring, complying with Division 26 Section 26 0513 "Wire and Cable."
2. Tap conductors to switches or relays: Stranded copper conductors of 16 AWG or solid 16 or 18 AWG with insulation rating equal to that of the line-voltage wiring.
3. Network cabling as required by manufacturer.

B. Splices and Taps:

1. Tapping or wire trap connectors shall be used to splice all Class 1 and Class 2 control wiring. Twist-on, wire-nut type connectors are not allowed.

PART 3 - EXECUTION

3.1 PRE-CONSTRUCTION MEETING

- A. Schedule a pre-construction meeting with the controls representative, installing contractor, Architect/Engineer, and Owner to explain the proposed lighting control programmable output levels and schedules..

3.2 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Verify field dimensions and coordinate physical size of all equipment with the architectural requirements of the spaces into which they are to be installed. Allow space for adequate ventilation and circulation of air.

- C. Verify that required utilities are available, in proper location, and ready for use.
- D. Beginning of installation means installer accepts existing conditions.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved shop drawings.
- B. Class II low voltage control wiring may be open wiring and shall maintain 150 mm (6 inch) spacing from electronic ballast and other RFI/EMI sources.
- C. All branch load circuits shall be live tested before connecting the loads to the lighting control panel.

3.4 SUPPORT SERVICES

- A. System Startup:
 - 1. Manufacturer shall provide factory authorized technician to confirm proper installation and operation of all system components.
- B. Testing:
 - 1. System shall be completely functional tested by a factory-authorized technician. All loads shall be tested live for continuity and freedom from defects, and all control wiring shall be tested for continuity and connections prior to energizing the system components.
 - 2. Programming of initial zones, schedules, lighting levels, control station groups, and sensor settings shall be performed by a factory-authorized technician. Lighting Control Sequence of Operation shall serve as a basis for programming. However, all final decisions regarding groups and schedules shall be at the direction of the Owner. The following procedures shall be performed at a minimum:
 - a. Confirm occupancy sensor placement, sensitivity, and time delay settings to meet specified performance criteria.
 - b. Confirm daylight sensor placement, sensitivity, deadband, and delay settings to meet specified performance criteria.
 - c. Confirm that schedules and time controls are configured to meet specified performance criteria and Owner's operating requirements.
 - 3. Verify occupancy/vacancy and daylight sensor operation is correct after furniture and equipment is installed in each area. Make adjustments to sensor settings and time delays to allow proper operation.
 - 4. Verify occupancy/vacancy sensors are located to provide complete coverage for the area served with no nuisance switching.
 - a. Relocate sensors or provide additional sensors as necessary to provide adequate coverage.
 - b. Mask occupancy sensors where necessary to prevent nuisance switching from adjacent areas.

C. Training:

1. Manufacturer shall provide competent factory-authorized technician to train Owner personnel in the operation, maintenance and programming of the lighting control system. Submit training plan with notification seven (7) days prior to proposed training dates.

D. Documentation:

1. Manufacturer shall provide system documentation including:
 - a. System one-line showing all panels, number and type of control stations and sensors, communication line, and network or BMS/BAS interface unit.
 - b. Drawings for each panel showing hardware configuration and numbering.
 - c. Typical diagrams for each component.

END OF SECTION

SECTION 26 2000 - SERVICE ENTRANCE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Arrangement with Utility Company for permanent electric service.
- B. Underground service entrance

1.2 RELATED SECTIONS AND WORK

- A. Refer to the One-Line Diagram for additional information.

1.3 SYSTEM DESCRIPTION

- A. System Voltage: 208Y/120 volts, three phase, four-wire, 60 Hertz.

PART 2 - PRODUCTS

2.1 METERING EQUIPMENT

- A. Meter: Furnished by the Utility Company.
- B. Metering Transformer Compartment: Furnished to Utility Company's specifications.
- C. Exterior Mounted Metering Cabinets: Furnished and installed by the Contractor to Utility Company's specifications. Conduit and conductors between metering cabinets and instrumentation shall be by the Contractor. Connections as required by the Utility Company.

2.2 IDENTIFICATION

- A. Provide a permanent plaque or sign denoting all services, feeders, and branch circuits supplying the building or structure and the area served by each. Install plaque or sign at each service disconnecting means.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Make arrangements with Utility Company to obtain permanent electric service to the Project.
- B. Primary distribution equipment and pad-mounted transformers shall be furnished and installed by the Utility Company.

- C. Primary conductors shall be furnished, installed, and terminated by the Utility Company. Primary conduit shall be furnished and installed by the Contractor, as shown on the drawings, to the Utility Company's requirements.
- D. Underground: Install service entrance conduits in concrete envelope from Utility Company's pad mounted transformer to meter cabinet and building service entrance equipment. Utility Company will connect service conductors to transformer secondary lugs.
- E. Concrete Pad for Transformer: Furnished and installed by the Contractor to Utility Company's specifications.

END OF SECTION

SECTION 26 2413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Main Distribution Switchboards: [MDP-#]

1.2 RELATED SECTIONS AND WORK

- A. Refer to the Electrical Distribution Diagram and Electrical Schedules for size, rating, and configuration.

1.3 REFERENCES

- A. ANSI C12 - Code for Electricity Metering
- B. ANSI C57.13 - Requirements for Instrument Transformers
- C. NEMA AB 1 - Molded Case Circuit Breakers
- D. NEMA KS 1 - Enclosed Switches
- E. NEMA PB 2 - Dead Front Distribution Switchboards

1.4 SUBMITTALS

- A. Include front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; switchboard instrument details; instructions for handling and installation of switchboard; and electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time-current curves of all equipment and components.
- B. Arc Energy Reduction Documentation: Submit documentation to demonstrate the arc energy reduction system is set to operate at a value below the available arcing current.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in 48-inch maximum width shipping splits, unless approved otherwise by both the Contractor and Architect/Engineer, individually wrapped for protection, and mounted on shipping skids.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle in accordance with NEMA PB2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 26 0500.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Approved Manufacturers:

1. Square D Class 2700 QED-2, I-Line, Powerstyle
2. Siemens
3. Eaton

2.2 RATINGS

- A. Definitions:

1. Series rated equipment shall be defined as equipment that can achieve a required UL AIC rating with an upstream device such as a main breaker or a combination of devices to meet or exceed a required UL AIC rating. All series rated equipment shall have a permanently attached nameplate indicating that device rating must be maintained. Refer to Section 26 0553 for additional requirements.
2. Fully rated equipment shall be defined as equipment where all devices in that equipment shall carry a minimum of the AIC rating that is specified.

- B. The switchboards for this project shall be fully rated.

2.3 SWITCHBOARD CONSTRUCTION AND RATINGS

- A. Factory-assembled, dead front, metal-enclosed, and self-supporting switchboard assembly conforming to NEMA PB2, and complete from incoming line terminals to load-side terminations.
- B. Switchboard electrical ratings and configurations as shown on the drawings.
- C. Line and Load Terminations: Accessible from the front only of the switchboard, suitable for the conductor materials used.
- D. Main Section Devices: Individually mounted and compartmented.
- E. Distribution Section Devices: Group or individually mounted.
- F. Auxiliary Section Devices: Individually mounted and compartmented.
- G. Bus Connections: Bolted, accessible from front only for maintenance. Plug-on connections may be utilized with Architect/Engineer's pre-approval by addenda.
- H. Bus bars shall be fully isolated, braced for minimum ampere rms symmetrical rating as indicated on drawings.

- I. The bus shall extend the full height of the distribution sections to provide space for future breakers.
 - J. Provide a 1 X 1/4-inch copper ground bus through the length of the switchboard.
 - K. Enclosure shall be NEMA PB 2; Type 1 - General-Purpose. Sections shall align at front and rear. Provide removable panel access or hinged door with flush lock and all keyed alike. Door hardware shall provide swing clear operation (180-degree swing).
 - L. Switchboard Height: NEMA PB 2; 92 inches, excluding floor sills, lifting members and pull boxes.
 - M. Maximum enclosure length shall be 72-inches.
 - N. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.
 - O. Pull Section: Same construction as switchboard, size as shown on the drawings. Depth and height to match switchboard. Arrange as shown on the drawings.
 - P. Future Provisions: In addition to the spare devices shown, provide a minimum of 15 inches of fully equipped space for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Continuous current rating as indicated on the drawings.
 - Q. Suitable for use as service entrance equipment. Provide line side (service style) barriers.
- 2.4 SWITCHING, OVER-CURRENT PROTECTIVE DEVICES, AND ARC ENERGY REDUCTION
- A. Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Provide breaker interrupting ratings as indicated on the plans. Where necessary to meet interrupting ratings, breakers shall be provided with automatically resetting current limiting elements in each pole.
 - B. Solid State Molded Case Circuit Breakers: Provide molded case switch with electronic sensing, timing, and tripping circuits for fully adjustable time current characteristic settings including ground fault trip, instantaneous trip, long time trip, long time delay, short time trip, and short time delay. Trip setting shall be field programmable with a sealable clear cover. Provide breaker interrupting ratings as indicated on the plans.
 - C. Arc Energy Reduction:
 - 1. Provide an arc energy reduction system to reduce the clearing time of an arc flash event. The arc energy reduction system shall be provided for overcurrent protection devices rated 1,200 amps or larger.
 - 2. Energy-Reducing Maintenance Switch: Provide an energy-reducing maintenance switch visual status indication when engaged. Install the maintenance switch in the first section of the electrical equipment.

2.5 INSTRUMENTS AND SENSORS

- A. Electronic Power Monitor: Refer to Section 26 0913.

2.6 CAPTURED KEY INTERLOCK SWITCH

- A. Captured Key Interlock Switch: Keyed switch, captured key style for interlock operation, corrosion resistant construction. Refer to plans for lock quantities, keyed-alike relationships, and additional information.
- B. Key: Custom heavy duty, non-snap under hand force, corrosion resistant, with key-ring / lanyard hole. Keys shall not be reproducible to prevent copying.
- C. Approved Manufacturers:
 - 1. Kirk Key (HD Key Series)
 - 2. Allen Bradley Bolt Interlock Series
 - 3. Haake HST Series

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install switchboard in locations shown on the drawings, in accordance with manufacturer's written instructions and NEMA PB 2.1.
- B. Tighten accessible bus connections and mechanical fasteners after placing switchboard.

3.2 FIELD QUALITY CONTROL

- A. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.
- B. Measure insulation resistance of each bus section phase to phase and phase to ground for one minute each. Test voltage shall be 1000 volts, and minimum acceptable value for insulation resistance is 2 megohms.
- C. Check tightness of accessible bolted bus joints using a calibrated torque wrench. Tightness shall be in accordance with manufacturer's recommended values.
- D. Physically test key interlock systems to ensure proper function.

3.3 ADJUSTING AND CLEANING

- A. Adjust all operating mechanisms for free mechanical movement.
- B. Touch up scratched or marred surfaces to match original finish.

- C. Provide time/current trip curves for all adjustable protection devices that require setting. Also provide curves and equipment information for associated new and existing fixed devices that require coordination with new protection devices. Submit time/current curves in hard copy or electronic format.
- D. Adjust trip and time delay settings to values as scheduled, or as instructed by the Architect/Engineer.
- E. Where two levels of ground fault are provided, test ground fault circuit breakers to prove selective coordination in accordance with manufacturer's directions. Provide testing documentation with Operating & Maintenance Manual submittals.

END OF SECTION

SECTION 26 2416 - PANELBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Lighting and appliance branch circuit panelboards: **Panel '###'**

1.2 RELATED SECTIONS AND WORK

- A. Refer to the Electrical Distribution Diagram and Electrical Schedules for size, rating, and configuration.

1.3 REFERENCES

- A. NEMA AB 1 - Molded Case Circuit Breakers
- B. NEMA PB 1 - Panelboards
- C. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less
- D. UL 67 - Panelboards

1.4 SUBMITTALS

- A. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

1.5 SPARE PARTS

- A. Keys: Furnish four (4) each to the Owner.

PART 2 - PRODUCTS

2.1 RATINGS

- A. Definitions:
 - 1. Series rated equipment shall be defined as equipment that can achieve a required UL AIC rating with an upstream device such as a main breaker or a combination of devices to meet or exceed a required UL AIC rating. All series rated equipment shall have a permanently attached nameplate indicating that device rating must be maintained. See Section 26 0553 for additional requirements.
 - 2. Fully rated equipment shall be defined as equipment where all devices in that equipment shall carry a minimum of the AIC rating that is specified.

- B. The panelboards for this project shall be fully rated unless otherwise specifically noted in the Drawings or Specifications.

2.2 BRANCH CIRCUIT PANELBOARDS

A. General

1. Basis of Design Manufacturer:

- a. Square D NQ
- b. Siemens
- c. Eaton

- B. Lighting and Appliance Branch Circuit Panelboards: NEMA PB 1; circuit breaker type.
- C. Enclosure: NEMA PB 1; Type 1.
- D. Provide cabinet front with hinged trim to allow access to wiring gutters without removal of trim and flush lock all keyed alike. Hinged trim shall be secured with screws. Door hardware shall provide swing clear operation (180-degree swing). Finish in manufacturer's standard gray enamel.
- E. Provide panelboards with copperbus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.
- F. All unlabeled circuits shown on the panelboard schedule shall be fully prepared spaces for future breakers.
- G. All multiple-section panelboards shall have the same dimensional back box and cabinet front size.
- H. Minimum Integrated Short Circuit Rating: As shown on the drawings.
- I. Provide handle lock-on devices for all breakers serving exit sign and lighting circuits with emergency battery units. Provide handle lock-on devices and red handles for breakers serving fire alarm panels.
- J. Molded Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled on the drawings. Do not use tandem circuit breakers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards plumb as indicated on the drawings in conformance with NEMA PB 1.1.
- B. Height: 6 feet to handle of highest device.
- C. Provide filler plates for unused spaces in panelboards.

- D. Provide custom typed circuit directory for each branch circuit panelboard. Label shall include equipment name or final approved room name, room number, and load type for each circuit (examples: SUMP SP-1 or ROOM 101 RECEIPT). Revise directory to reflect circuit changes required to balance phase loads. Printed copies of the bid document panel schedules are not acceptable as circuit directories.

3.2 FIELD QUALITY CONTROL

- A. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.
- B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

END OF SECTION

SECTION 26 2419 - MOTOR CONTROL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Manual motor starters

1.2 RELATED SECTIONS AND WORK

- A. Refer to the Disconnect and Starter Schedule and One-Line Diagram for rating and configuration.

1.3 SUBMITTALS

- A. Indicate on shop drawings, front and side views of motor control center enclosures with overall dimensions. Include conduit entrance locations and requirements; wiring diagrams that differentiate between manufacturer-installed and field-installed wiring; nameplate legends; size and number of bus bars per phase, and ground; electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time-current curves of all equipment and components.
- B. Provide product data on motor starters and combination motor starters, relays, pilot devices, and switching and over-current protective devices.

1.4 OPERATION AND MAINTENANCE DATA

- A. Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

PART 2 - PRODUCTS

2.1 MANUAL MOTOR STARTERS

- A. Acceptable Manufacturers:
 - 1. Square D 2500 Series
 - 2. Eaton MS Series
 - 3. Siemens SMF / MMS Series
- B. Manual Motor Starter: NEMA ICS 2; AC general-purpose Class A manually operated non-reversing full-voltage controller for induction motors rated in horsepower, with overload relay, and toggle operator.
- C. Fractional Horsepower Manual Starter: NEMA ICS 2; AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, and toggle operator.

- D. Motor Starting Switch: NEMA ICS 2; AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, and toggle operator.
- E. Enclosure: NEMA ICS 6; Type 1.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install motor control equipment in accordance with manufacturer's instructions on concrete bases.
- B. Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

END OF SECTION

SECTION 26 2726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Device plates and box covers
- B. Receptacles (REC-#)
- C. Multi Outlet System (WM-#)

1.2 QUALITY ASSURANCE

- A. Provide similar devices from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the Electrical Code, by a testing agency to Authorities Having Jurisdiction and marked for intended use.
- C. Comply with the Electrical Code.

1.3 REFERENCES

- A. DSCC W-C-896F - General Specification for Electrical Power Connector
- B. FS W-C-596 - Electrical Power Connector, Plug, Receptacle, and Cable Outlet
- C. NEMA WD 1 - General Color Requirements for Wiring Devices
- D. NEMA WD 6 - Wiring Devices - Dimensional Requirements
- E. NFPA 70 - National Electrical Code (NEC)
- F. UL 943 - Standard for Ground Fault Circuit Interrupters

1.4 SUBMITTALS

- A. Provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.

1.5 COORDINATION

- A. Receptacles for Owner Furnished Equipment: Match plug configurations.

PART 2 - PRODUCTS

2.1 DEVICE COLOR

- A. All switch, receptacle, and outlet colors shall be verified with Architect, unless indicated otherwise.

2.2 COVERPLATES

- A. All switches, receptacles, and outlets shall be complete with the following:
 - 1. Unbreakable thermoplastic/thermoset plastic and match device color coverplates in finished spaces where walls are finished.
 - 2. #302 stainless steel coverplates in unfinished spaces for flush boxes.
 - 3. Galvanized steel coverplates in unfinished spaces for surface mounted boxes.
- B. Where several devices are ganged together, the coverplate shall be of the ganged style for the number of devices used.
- C. Install nameplate identification as indicated in Section 26 0553.
- D. Plate securing screws shall be metal with head color matching the wall plate finish.

2.3 RECEPTACLES

- A. Refer to Electrical Symbols List for device type.
- B. REC-DUP: NEMA 5-20R Duplex Receptacle:
 - 1. Standard Grade: 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face and steel back strap.
 - a. Manufacturers:
 - 1) Hubbell 5352A
 - 2) Leviton, 5362-S
 - 3) Pass & Seymour 5362
 - 4) Cooper 5352
- C. REC-DUP-GFI: NEMA 5-20R Ground Fault Duplex Receptacle:
 - 1. Standard Grade: 125-volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face.
 - a. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
 - b. Manufacturers:
 - 1) Hubbell GF20L
 - 2) Leviton GFNT2

- 3) Pass & Seymour 2097
- 4) Cooper SGF20

D. REC-DUP-WP: NEMA 5-20R Weatherproof Ground Fault Duplex Receptacle:

1. 125-volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face, weather resistant WR listed. Provide extra-duty NEMA 3R rated while-in-use cast aluminum cover.
2. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
 - a. Manufacturers:
 - 1) Hubbell:
 - a) GFTWRST20 with aluminum housing WP826
 - 2) Leviton GFWT2 with aluminum housing M5979
 - 3) Pass & Seymour 2097TRWR with aluminum housing WIUCAST1
 - 4) Cooper WRSGF20 with aluminum housing WIUMV-1

E. REC-SIM-620R: NEMA 6-20R Simplex Receptacle:

1. 250-volt, 20 amp, 2-pole, 3-wire grounding type with thermoplastic face. Provide extra-duty NEMA 3R rated while-in-use cast aluminum cover.
 - a. Manufacturers:
 - 1) Hubbell HBL5461
 - 2) Leviton 5461
 - 3) Pass & Seymour 5871
 - 4) Cooper 5461

F. REC-SIM-1430R: NEMA 14-30R Simplex Receptacle:

1. 125/250-volt, 30 amp, 3-pole, 4-wire grounding type with thermoplastic face. Flush mounted at +24 AFF.
 - a. Manufacturers:
 - 1) Hubbell HBL9430A
 - 2) Leviton 278
 - 3) Pass & Seymour 3864
 - 4) Cooper 5744N

G. REC-TAMP: NEMA 5-20R Tamper Resistant Duplex Receptacle:

1. Standard Grade: 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face.
 - a. Manufacturers:

- 1) Hubbell BR20TR
- 2) Leviton TBR20
- 3) Pass & Seymour TR5362
- 4) Cooper TRBR20

H. REC-QUAD: NEMA 5-20R Double Duplex Receptacle:

1. Consists of two duplex receptacles, double gang box, plaster ring and faceplate.

a. Manufacturers:

- 1) Refer to Duplex Receptacle above.

I. REC-QUAD-GFI: NEMA 5-20R Double Duplex GFI Receptacle:

1. Consists of two duplex GFI receptacles, double gang box, plaster ring and faceplate.

a. Manufacturers:

- 1) Refer to Duplex GFI Receptacle above.

J. Back wired devices shall be complete with eight holes that are screw activated with metal clamps for connection to #12 or #10 copper conductors.

K. Side wired devices shall have four binding screws that are undercut for positive wire retention.

L. Ground fault circuit interrupter (GFCI) receptacles shall comply with UL 943 requiring increased surge immunity, improved corrosion resistance, improved resistance to false tripping and diagnostic indication for miswiring if the line and load conductors are reversed during installation.

2.4 MULTI OUTLET SYSTEM ASSEMBLIES

A. [WM-1]: Multi-outlet Assembly: FS W-C-582; sheet metal channel with fitted cover, with pre-wired receptacles, suitable for use as a multi-outlet system. Surface mount.

B. Receptacles: Convenience receptacle mounted in cover 6 inches on center. Receptacles shall be 15-amp, 125-volt, 3-wire, grounding type, specification grade. Single Alternating circuit type.

C. Finish: Coordinate with Architect.

D. Fittings: Couplings, elbows, outlet and device boxes, and connectors designed for use with multi-outlet system. Provide all miscellaneous fittings for an electrically continuous system.

1. Manufacturers:

- a. Wiremold 2000 Series
- b. Mono-Systems 1900 Series
- c. Hubbell HBL2000 Series

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install convenience receptacles at elevations indicated in the General Installation Notes on the contract drawings.
- B. Install specific-use receptacles at heights shown on the contract drawings. Install devices level, plumb, and square with building lines. Coordinate installation of adjacent devices of separate systems with common mounting heights, including lighting, power, systems, technology, and temperature control device rough-ins.
- C. Ground Fault Protection: Provide ground fault protection for all branch circuit breakers serving 120/208 receptacle outlets rated 21 - 50 amps single phase and 21-100 amps three phase in the following locations, as shown on drawings, or required by adopted code:
 - 1. Bathrooms, locker rooms, shower rooms
 - 2. Kitchens
 - 3. Rooftops
 - 4. Interior/Exterior locations subject to damp/wet conditions
 - 5. When located within 6 feet of sinks, bathtubs, and shower stalls
- D. Tamper Resistant Protection: Provide tamper resistant protection for all 15 / 20-amp 120/208 straight blade wiring devices in the following locations, as shown on the drawings, or required by adopted code.
 - 1. Public Buildings: Corridors, waiting rooms, common areas
- E. Install receptacles vertically with ground slot up or where indicated on the drawings, horizontally with ground slot to the left.
- F. Install decorative plates on switch, receptacle, and blank outlets in finished areas, using jumbo size plates for outlets installed in masonry walls.
- G. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface-mounted outlets.
- H. Install devices and wall plates flush and level.
- I. Install nameplate identification to receptacle cover plates indicated. Identification shall identify panel name and circuit number. Refer to Specification Section 26 0553 - Electrical Identification.
- J. Test receptacles and modular wiring connectors for proper polarity, ground continuity and compliance with requirements.

END OF SECTION

SECTION 26 2816 - DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fusible switches
- B. Non-fusible switches

1.2 RELATED SECTIONS AND WORK

- A. Refer to the Disconnect and Starter Schedule for rating and configuration.

1.3 REFERENCES

- A. NEMA KS 1 - Enclosed Switches

1.4 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breakers, accessory and component indicated, include dimensions, weights, and manufacturer's technical data on features, performance, and ratings.
- B. Electrical Characteristics: For each type of enclosed switch, enclosure types, current and voltage ratings, short-circuit current ratings, UL listing for series rating of installed devices, features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

1.5 COORDINATION

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

PART 2 - PRODUCTS

2.1 FUSIBLE AND NON-FUSIBLE SWITCHES

- A. Acceptable Manufacturers:
 - 1. Square D 3110 Series
 - 2. Eaton DH Series
 - 3. ABB TH Series
 - 4. Siemens HNF / HF Series

- B. FDS-#; Fusible Switch Assemblies: NEMA KS 1; Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: Class 'R' fuse clips only, unless indicated otherwise on the drawings.
- C. DS-#; Non-fusible Switch Assemblies: NEMA KS 1; Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.
- D. Enclosures: Type as indicated on the disconnect schedule.
- E. Accessories: As indicated on the disconnect schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install disconnect switches where indicated on the drawings.
- B. Install fuses in fusible disconnect switches.
- C. Provide adhesive label on inside door of each switch indicating UL fuse class and size for replacement.

END OF SECTION

SECTION 26 4300 - SURGE PROTECTION DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section describes materials and installation requirements for factory and field wired low voltage surge protection devices (SPD) for the protection of all AC electrical circuits. SPD equipment to be installed at designated service entrance equipment and electronic equipment.

1.2 QUALITY ASSURANCE

- A. The specified unit shall be designed, manufactured, tested and installed in compliance with the above references. The unit shall be "Listed by Underwriters Laboratories" to UL 1449.
- B. Each unit shall be designed and manufactured by a qualified manufacturer of power conditioning equipment. The qualified manufacturer must have been engaged in the design and manufacturer of such products for a minimum of five years.

1.3 SUBMITTALS

- A. Shop Drawings: Should include device dimensions, mounting requirements including wire size and over-current protection device rating, nameplate nomenclature, electrical ratings, short circuit current rating, and test results as indicated below under "Testing, Warranty and Life Expectancy" as provided by an independent test lab or a UL certified test lab for the category(ies) of suppression device(s) specified using the appropriate IEEE test wave. Product data sheets with installation instructions for each size and type of device are required. Shop drawings submitted without the testing data as required by section this section will be rejected.

1.4 TESTING, WARRANTY AND LIFE EXPECTANCY

- A. Minimum Repetitive Surge Current Capacity:
 - 1. Service entrance suppressor units should be tested repetitively at an independent lab to verify repetitive capacity.
 - 2. Minimum Repetitive Surge Current Capacity Test:
 - a. An initial UL 1449 surge defined as 1.2 x 50 μ s, 6000V open circuit voltage waveform and an 8 x 20 μ s, 500A and 3kA short circuit current waveform shall be applied to benchmark the unit's suppression voltage.
 - b. A repetitive number of ANSI/IEEE C62.41.2-2002 (Category C3) surges, defined as a 1.2 x 50 μ s 10kV or 20kV open circuit voltage waveform and an 8 x 20 μ s 10,000A short circuit current waveform, shall then be applied at one-minute intervals.
 - c. To complete the test, another UL 1449 surge shall be applied to verify the unit's survival.
- B. Provide UL 1449 classification white sheet pages indicating the VPR (voltage protection rating) for each SPD unit submitted for this product using the 6kV/3kA combination wave surge.

- C. Warranty: Ten (10) years. Includes workmanship, installation and programming.
- D. No scheduled parts replacement or preventative maintenance shall be required.

PART 2 - PRODUCTS

2.1 DESCRIPTION

- A. General: The unit shall provide transient voltage suppression, surge current diversion and high-frequency noise attenuation, when connected in parallel to the facilities distribution system. The unit MCOV shall not be less than 115% of the nominal system voltage. Operating frequency shall be for a 60 Hz system. The unit shall provide protection in all normal modes for "wye" and "delta" systems.
- B. Short Circuit Current Rating: Provide factory label for SCCR rating. The short circuit current rating shall be the larger of the listed value on the drawings or as required by the equipment protected.

2.2 RATINGS

A. **SPD-1; Service Entrance Suppressors:**

- 1. For 120/208-volt, 3 phase, 4 wire, type 2, category C3 unit.
 - a. Surge current capacity: 100,000/200,000 amps per protection mode/phase
 - b. Nominal Discharge Current: 20 kA.
 - c. Mounting: Refer to the drawings.
 - d. Voltage Protection Rating: Refer to requirements below.
 - e. Components: Minimum component size of 20mm thermally protected metal oxide varistors (MOV).
 - f. Disconnect: Surge-rated disconnect with 200,000 SCCR.
- 2. Manufacturers:
 - a. Square D Surgelogic EMA Series
 - b. Siemens TPS3 Series
 - c. Eaton SPD Series
 - d. Current Technology Current Guard Plus
 - e. ASCO Power Technologies 400 Series
 - f. LEA International LSS Series

B. **Critical Load Protection - Fixed Equipment:**

- 1. For 120-volt, 1 phase, 3 wire, type 3, category A3 unit.
 - a. Surge Current Capacity (I_N): 15,000 amps per protection phase
 - b. Mounting: External, NEMA 1 enclosure
 - c. Components: Nonmodular units composed of 20mm metal oxide varistors (MOV). Series inductors, SAD, or selenium cells may be used in addition to MOVs.

- d. Protection Modes and UL 1449 Clamping Voltage: 700 volt L-N, L-G, and 900 volt N-G.
2. Manufacturers:
 - a. Square D
 - b. Siemens
 - c. Eaton
 - d. Current Technologies
 - e. ASCO Power Technologies
 - f. LEA International
 - g. Mersen
 - h. Or approved equal
- C. Voltage Protection Rating:
1. Protection modes and UL 1449 voltage protection rating for surge suppression units per each mode (L-N, L-L, L-G, and N-G as appropriate).
 - a. 120/208 Volt, 3 phase, 4 wire. 700 Volt L-N, N-G, 800 Volt L-G and 1200 Volt L-L
- D. Indication:
1. Each unit shall include solid-state indicators with externally mounted LED visual status indicators that indicate on-line status of each protection mode of the unit.
 2. Each unit shall include an audible alarm with silencing switch to indicate when protection has failed.
- E. Fuses:
1. Use fuses recommended by the manufacturer to satisfy repetitive UL 1449 operation of the surge suppression unit.
 2. Fuses shall be rated 200, 000 AIC minimum interrupting capacity.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine equipment for size and type of surge protection device to be used to ensure physical compatibility.
- B. Inspect surge protection device for any signs of physical damage due to shipping or handling before installing surge protection device.

3.2 INSTALLATION

- A. Mounting Location:
 1. Integral surge protection devices mount between the main and branch circuit breakers.

2. If internal surge protection device is specified, device shall be installed in a barrier compartment isolated from other components.

B. Connections:

1. Contractor shall provide wire and circuit breakers sized per the approved manufacturer's requirements. Maximum lead length from protected bus to surge protection device shall be per manufacturer's requirements, but no greater than 5'-0".
2. The surge protection unit shall be isolatable from the electrical distribution system via 3 pole circuit breaker mounted in the switchboard/panelboard. Single phase 120-volt units shall be hardwired without a disconnecting means.
3. Neutral and ground shall not be bonded together at secondary panelboard locations.

C. Additional Locations: Critical Load Protection - Fixed Equipment (120 Vac):

1. Install an A3 hard-wired surge protection device between each of the following equipment items and its power supply conductors.
 - a. Fire alarm master panel

D. General:

1. Check unit for proper operation of protection and indication under start-up.
2. Check unit to ensure all MOVs for each mode of protection are operational. Verify integral fuse links are operational and have not melted.
3. Surge suppression devices shall not be installed ahead of the main service disconnect(s).
4. Install fuses in all fuse holders and fused disconnects internal to the surge protection unit. Use fuses recommended by the manufacturer to satisfy repetitive UL 1449 operation of the surge suppression unit. External fusing of the surge protection device is not allowed.
5. Coordinate location of surge protection device to allow adequate clearances for maintenance.
6. Manufacturer service phone number shall be posted on the front of the surge protection device.

END OF SECTION

SECTION 26 5119 - LED LIGHTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Interior luminaires and accessories
- B. Exterior luminaires and accessories
- C. Light-emitting diode (LED) luminaire systems
- D. LED emergency lighting units
- E. Emergency exit signs
- F. Lighting poles

1.2 RELATED SECTIONS

- A. The lighting system design includes a combination of luminaire sources, lighting control components, programming sequences, and supplementary components for building and energy code compliance. The design uses performance-based specifications for portions of the lighting system to account for the limitation of comparable product solutions available by competitive manufacturers. The Contractor shall reference related specification sections, plans, schedules, and details prior to submitting pricing, submittals, and installation. The Contractor shall coordinate system component compatibility among various manufacturers and suppliers for a turnkey lighting system. Referenced sections include, but are not limited to, the following:
 - 1. 26 09 33 Lighting Control Systems
 - 2. 26 52 15 Emergency Lighting Inverter
 - 3. Electrical drawings: Plans, luminaire schedules, lighting control sequence of operations, diagrams, and details.

1.3 REFERENCES

- A. ANSI C82.16 - Light-Emitting Diode Drivers - Method of Measurement
- B. NFPA 70E - National Electrical Safety Code
- C. NEMA SSL1 - Electronic Drivers for LED Devices, Arrays or System
- D. UL 8750 - Light Emitting Diode (LED) Equipment for use in Lighting Products
- E. FS W-L-305 - Light Set, General Illumination (Emergency or Auxiliary)
- F. UL 924 - Standard for Emergency Lighting and Power Equipment

1.4 SUBMITTALS

A. Basic Requirements of Submittal:

1. Submit product data sheets for luminaires, LED light engines, drivers and poles. Include complete product model number with all options as specified. Submittal shall be arranged with luminaires listed in ascending order, and with each luminaire's, LED light engine, driver, or pole information following luminaire's product data. Failure to organize submittal in this manner will result in the submittal being rejected.
2. Include outline drawings, support points, weights, and accessory information for each luminaire.

B. LEED Requirements:

1. Light Pollution Reduction:

- a. Exterior Luminaires: Submit manufacturer Backlight Uplight Glare (BUG) rating including data showing percentage of light lumens emitted at or above 90° from nadir for each luminaire type.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect luminaire finishes, lenses, and trims from damage during storage and installation. Do not remove protective films until construction cleanup within each area is complete.
- B. Handle site lighting poles carefully to prevent breakage and damage to finish.

1.6 WARRANTY

A. The warranty period begins at the date of Substantial Completion.

B. LED Light Engines and Drivers:

1. LED Drivers and Dimming Drivers: Five (5) years
2. Light Emitting Diode (LED) Light Engines: Five (5) years

C. Emergency Lighting Units and Exit Signs:

1. Emergency Lighting Units: Three (3) year, non-prorated
2. Exit Signs: Three (3) year, non-prorated
3. Emergency Unit and Exit Sign Battery: Sealed lead acid or lead calcium cell, requiring no maintenance or replacement for ten (10) years under normal conditions.

D. Emergency Drivers:

1. Emergency LED Driver: Five (5) years

E. Emergency Inverter for LED Light Engines:

1. Emergency Inverter and Battery: Sealed nickel cadmium five (5) year, non-prorated.

- F. Pole Finish: Three (3) year warranty of pole color and finish

1.7 REGULATORY REQUIREMENTS

- A. Conform to NFPA 101 for installation requirements

PART 2 - PRODUCTS

2.1 INTERIOR LUMINAIRES AND ACCESSORIES - GENERAL

- A. Lensed Troffers: Provide hinged frames with latches and 0.125-inch thick virgin acrylic lenses. Prismatic lenses shall have depth of no less than 0.080", KSH12 or equal. Other lenses as scheduled.
- B. Recessed Luminaires: Confirm ceiling and wall type and furnish trim and accessories necessary to permit proper installation in each system. Where fire-rated ceiling or wall assemblies are specified, furnish and install listed enclosures around luminaires that maintain the system rating.
- C. Luminaires: Louvers shall be anodized low iridescent specular aluminum with mitered corners and interlocking construction.
- D. Suspended Luminaires: Coordinate power feed and suspension canopies with ceiling type and architectural RCP for proper fit and location. Ensure finished installations are plumb and level at elevations specified. Verify suspension length prior to submittal.
- E. Painted reflector surfaces shall have a minimum reflectance of 90%.
- F. All painted components shall be painted after fabrication.

2.2 EXTERIOR LUMINAIRES AND ACCESSORIES - GENERAL

- A. Listed for wet or damp location as scheduled. Provide ingress protection (IP) rating when scheduled.
- B. Provide low temperature LED drivers, with reliable starting to -20°F.
- C. In-grade luminaires shall have lamp/optic separation to prevent surface temperature from exceeding 115°F. Compartment separation of wire entry and control gear/lamp chamber.
- D. Exterior LED luminaires shall contain separate, easily accessible and replaceable Category C surge protection device.

2.3 LIGHT EMITTING DIODE (LED) LUMINAIRE SYSTEMS

- A. Refer to the luminaire schedule for color temperature and minimum color rendering index CRI requirements. Provide light source color consistency by utilizing a binning tolerance within a maximum 3-step McAdam ellipse unless noted otherwise.

- B. LED chip arrays specified as color changing shall have chip colors as noted on the luminaire schedule.
- C. Rated life shall be minimum of 50,000 hours at L70.
- D. LED chips shall be wired so that failure of one chip does not prohibit operation of the remainder of the chip array.
- E. Luminaire delivered lumens is defined as the absolute lumens per the manufacturers LM-79-08 test report.
- F. LED luminaires shall be designed for ease of component replacement including modular replaceable boards or Zhaga sockets. Luminaires that are factory sealed and do not have field replaceable parts shall provide a 10-year warranty.
- G. LED light engine shall have a maximum LLD of 0.85 at 50,000 hours at 25°C ambient.
- H. LED Driver:
 - 1. Solid state driver with integral heat sink. Driver shall have over-heat, short-circuit and overload protection, power factor 0.90 or above and maximum total harmonic distortion of 10%. Driver shall have a voltage fluctuation tolerance of +/- 10%.
 - 2. Drivers shall have dimming capabilities as outlined in the luminaire schedule for each luminaire type. Dimming shall control light output in a continuous curve from 100% to 10% unless noted otherwise.
 - 3. Driver shall have a minimum of 50,000 hours rated life.
 - 4. Driver shall be tested to ANSI C82-16 for input current inrush, total harmonic distortion (THD), and power factor. Driver start time shall be less than 0.5 seconds to 98% of initial light output. Flicker should be less than 30% throughout the operating range.
 - 5. Driver shall be field replaceable without removal of the luminaire.
 - 6. Class A sound rating; inaudible in a 27 dBA ambient.
 - 7. Demonstrate no visible change in light output with a variation of plus or minus 10 percent change in line-voltage input.

2.4 LED EMERGENCY LIGHTING UNITS

- A. Self-Powered Emergency Lighting Units: One-piece, self-contained unit with sealed, maintenance-free nickel cadmium battery, automatic charger and electronic circuitry. 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.
- B. Battery: Maintenance free lead calcium type, with 90 minute capacity to supply the connected lamp load.
- C. Charger: Dual-rate solid state current limiting charger, capable of maintaining the battery in a full-charge state during normal conditions, and capable of recharging discharged battery to full charged within 168 hours. Low voltage disconnect to prevent deep discharge of battery.
- D. LED Lamp Wattage: As scheduled on luminaire schedule.

- E. Remote Lamps: Match LED lamps on unit.
- F. Indicators: Provide lamps to indicate AC ON and RECHARGING.
- G. Provide test switch to transfer unit from normal supply to battery supply.
- H. Electrical Connection: Knockout for conduit connection.
- I. Unit Voltage: Refer to luminaire schedule volts, AC.
- J. Self-Diagnostics and Testing:
 - 1. Unit shall be self-diagnostic with continuous monitoring of charger performance and battery voltage. Any malfunction of battery, charger, transfer circuit, or emergency lamps shall be detected and visually indicated.
 - 2. Unit shall be programmed to exercise the battery and test emergency operation by performing a five-minute discharge/diagnostic cycle every six months. A manual test switch shall allow a five-minute discharge/diagnostic test at any time.

2.5 EMERGENCY EXIT SIGNS

- A. Exit Signs: Stencil face, 6-inch high letters, directional arrows as indicated, universal mounting type as indicated on the drawings.
- B. Directional Indicators: The directional indicator for exit signage shall be of a chevron type meeting all requirements of NFPA 101.

2.6 LIGHTING POLES

- A. Refer to Luminaire Schedule description.
- B. Wind Load: 100 MPH velocity, with 1.3 gust factor with luminaires and brackets mounted.
- C. Hand Hole: 2 x 4 inches with removable weatherproof cover installed at manufacturer's standard location. Provide matching gasketed cover plate.
- D. Anchor Bolts: As recommended by pole manufacturer. Provide template, flat washers, lock washers, and hex nuts for each pole. Grout between anchor plate and concrete base with non-shrink grout after pole is plumbed.
- E. Vibration Damper: Canister or snake type second mode vibration damper internal to the metal pole as recommended by pole manufacturer. Provide additional pole top damper for first mode vibration on single-head metal poles where recommended by manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Securely fasten luminaires to the listed and labeled ceiling framing member by mechanical means such as bolts, screws, rivets or listed clips identified for use with the type of ceiling framing members. The architectural ceiling framing system may be used in lieu of independent support with prior written approval by the ceiling system manufacturer and Authority Having Jurisdiction (AHJ). Luminaires and wiring installed in fire-rated ceiling assemblies shall be independently supported for all applications.
 - 1. Install recessed flanged luminaires to permit removal from below. Use manufacturer-supplied plaster frames and swing gate supports. Provide independent support as follows:
 - a. Luminaires less than 56 lbs: Provide a minimum of two (2) #12 gauge suspended ceiling support wires located on diagonal corners of the luminaires.
 - b. Luminaires 56 lbs or greater: Provide a minimum of four (4) #12 gauge suspended ceiling support wires located on diagonal corners of the luminaires. Support luminaire independent of the ceiling system.
 - c. Luminaires larger than eight square feet (8 ft²): Support luminaire independent of the ceiling system.
- B. Do not fasten luminaire supports to piping, ductwork, mechanical equipment, or conduit, unless otherwise noted. Support wires shall be tightly wrapped (minimum of three turns within 3 inches of the connection) and sharply bend to prevent vertical movement.
- C. Support suspended or pendant mounted luminaires independent of ceiling grid with adjustable stainless steel aircraft cables or per luminaire schedule mounting requirements. Suspension assembly and anchors shall be capable of supporting 300 pounds dead load at each suspension point.
- D. Support wire used to independently support luminaires, raceways, and wiring systems shall be distinguishable from ceiling support systems by color (field paint), tagging or equivalent means.
- E. Install lamps in lamp holders of luminaires.
- F. Adjust aimable luminaires to obtain lighting levels on objects and areas as directed to obtain desired lighting levels.
- G. Recessed luminaires and other optical accessories shall remain in protective wraps or films until construction in area is complete and area has been cleaned.
- H. Luminaire Pole Bases: Sized and constructed as indicated on the drawings. Project anchor bolts 2 inches minimum above base. Install poles plumb with double nuts for adjustment. Grout around pole anchor base.
- I. Embedded Luminaire Poles: Depth as indicated on drawing detail. Install plumb.
- J. Use belt slings or non-chafing ropes to raise and set pre-finished luminaire poles.

3.2 CONSTRUCTION USE OF PROJECT LUMINAIRES

- A. The Contractor shall provide temporary construction lighting per the requirements of Division 1.
- B. The project luminaires shown on the construction documents shall not be used for temporary construction purposes without providing a plan for Owner approval that addresses energy and luminaire operating hours.

3.3 EMERGENCY LIGHTING UNITS AND EXIT SIGNS

- A. Install units plumb and level.
- B. Aim directional lamp heads as directed.
- C. Test emergency lighting equipment for 60 minutes to determine proper operation, prior to Substantial Completion. Provide electronic copy of periodic test log form to Owner's Representative. Explain and instruct Owner's Representative of requirements for testing and maintenance. Refer to latest adopted NFPA 101 for testing and logging requirements.

3.4 RELAMPING

- A. Replace failed LED light engine modules or arrays at completion of work.

3.5 ADJUSTING AND CLEANING

- A. Align luminaires and clean lenses and diffusers at completion of work. Clean paint splatters, dirt, and debris from installed luminaires.
- B. Touch up luminaire and pole finish at completion of work.

3.6 OWNER TRAINING

- A. Test emergency lighting equipment for 60 minutes to determine proper operation, prior to Substantial Completion, with the Owner's Representative.

3.7 LUMINAIRE SCHEDULE

- A. As shown on the drawings.

END OF SECTION

SECTION 26 5215 - EMERGENCY LIGHTING INVERTER

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Emergency lighting inverter **INV**

1.2 REFERENCE AND REGULATORY

- A. UL924 - Standard Emergency Lighting and Power Equipment
- B. UL924A - Auxiliary Lighting
- C. NFPA 101 - Life Safety Code
- D. NFPA 111 - Standard on Stored Electrical Energy Emergency and Standby Power Systems
- E. ANSI C62.41 (IEEE 587)
- F. ANSI C62.42.45 (Cat A & B)

1.3 RELATED SECTIONS

- A. The lighting system design includes a combination of luminaire sources, lighting control components, programming sequences, and supplementary components for building and energy code compliance. The design uses performance-based specifications for portions of the lighting system to account for the limitation of comparable product solutions available by competitive manufacturers. The Contractor shall reference related specification sections, plans, schedules, and details prior to submitting pricing, submittals, and installation. The Contractor shall coordinate system component compatibility among various manufacturers and suppliers for a turnkey lighting system. Referenced sections include, but are not limited to, the following:

1. 26 51 19 LED Lighting
2. Electrical drawings: Plans, luminaire schedules, lighting control sequence of operations, diagrams, and details

1.4 SUBMITTALS

- A. Indicate unit ratings, dimensions, and finishes. Include performance data for batteries.
- B. Submit manufacturer's installation instructions under provisions of Section 26 0500.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Section 26 0500.
- B. Store and protect products under provisions of Section 26 0500.

1.6 SYSTEM DESCRIPTION

- A. System Configuration: Emergency lighting inverter, line interactive, solid-state power supply with cabinet enclosure.
- B. Operating Sequence: When utility power is available, it is supplied by the normal power source. When utility power fails, the load is transferred to the emergency battery. When utility is restored, load is retransferred and battery charger restores battery charge.

1.7 OPERATION AND MAINTENANCE DATA

- A. Include battery maintenance and unit testing procedures.

1.8 WARRANTY

- A. Emergency Lighting Inverter: One (1) year
- B. Battery: Sealed lead calcium VRLA, ten (10) year

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Myers Emergency Power System Illuminator Series
- B. Signify Chloride HC Series
- C. Acuity Lithonia Lighting EAC Series
- D. Perfect Power Systems Power Ride Series

2.2 EMERGENCY LIGHTING INVERTER

- A. Emergency lighting inverter, line interactive, solid-state power supply with cabinet enclosure. The system shall be suitable LED, and fluorescent lamp sources without extinguishing the illumination arc upon load transfer. UL924 listed latest edition.
- B. Input/Output Voltage: 120 volts, 60 Hertz, single phase
- C. Output Power: 2.8 KW at 1.0 power factor. The inverter shall have the ability to supply the rated Kw from a power factor of 0.7 lagging to 0.7 leading. Overload capability of 115% for 2 minutes.
- D. Battery Operating Time: 90 minutes at full load and within output voltage limits.
- E. Battery: Lead calcium, sealed maintenance-free type. Low voltage battery disconnect protects the battery from "deep discharge" during prolonged power outages.
- F. Charger: Designed to maintain battery in full-charge condition during normal conditions.

- G. Self-Test and Self-Diagnostics: Provide unit with self-test and self-diagnostics capability. Include the following automatically programmed tests and diagnostics:
 - 1. Monthly Test and Diagnostics: NFPA compliant
 - 2. Yearly Test and Diagnostics: 90 minutes NFPA compliant
 - 3. History and Recording: History log shall maintain at least three (3) years of test, diagnostic, and alarm event data.

- H. Input Circuit Breakers:
 - 1. Provide input circuit breakers: 3 single pole 15-amp circuit breakers.

* * * * * OR * * * * *

- I. Output Circuit Breakers:
 - 1. Provide output circuit breakers: 3 single pole 15-amp circuit breakers.

- J. Accessories:
 - 1. Maintenance Bypass: maintenance bypass switch.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units plumb and level with required clearances.
- B. Provide interconnection between cabinets.
- C. Branch Circuit: The manufacturer recommended input circuit breaker size may vary between manufacturers. Provide branch circuit breaker and wire size per manufacturer recommendations in lieu of the scheduled sizes when applicable.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Include services of technician to supervise adjustments, final connections, and system start-up.

END OF SECTION

SECTION 27 0500 - BASIC COMMUNICATIONS SYSTEMS REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Basic Communications Systems Requirements specifically applicable to Division 27 sections, in addition to Division 1 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 SCOPE OF WORK

- A. This Specification and the associated drawings govern furnishing, installing, testing and placing into satisfactory operation the Communications Systems.
- B. The Contractor shall furnish and install all new materials as indicated on the drawings, and/or in these specifications, and all items required to make the portion of the Communications Work a finished and working system.
- C. Separate contracts will be awarded for the following work.
- D. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.
- E. Separate contracts will be awarded for the following work. The division of work listed below is for the contractors' convenience and lists a normal breakdown of the work. Please refer to the Construction Manager's scope statements for complete scope of work description.
- F. Description of Systems include, but are not limited to, the following:
 - 1. Complete Structured Cabling System including, but not limited to:
 - a. Voice and data backbone cabling and terminations.
 - b. Voice and data horizontal cabling and terminations.
 - c. Information outlets (IOs) including faceplates, jacks and labeling.
 - d. Equipment racks, cabinets, cable management and equipment.
 - e. Telecommunication Room equipment including patch panels, optical distribution cabinets, and termination blocks.
 - f. Cabling pathways.
 - g. Grounding and Bonding
 - h. Testing
 - 2. Complete Data Communications Equipment Systems.
 - 3. Complete Voice Communications Equipment Systems.
 - 4. Complete Audio/Visual Systems.

5. Mounting and patching of wireless access points provided by others.
6. Low Voltage Communications Wiring (less than +120VAC) as specified and required for proper system control and communications.
7. All associated electrical backboxes, conduit, miscellaneous cabling, and power supplies required for proper system installation and operation as defined in the "Suggested Matrix of Scope Responsibility".
8. Firestopping of penetrations as described in Section 27 0503.
9. Seismic requirements as described in Section 26 0548 "Seismic Requirements for Equipment and Supports".

1.3 DIVISION OF WORK BETWEEN ELECTRICAL AND COMMUNICATIONS CONTRACTORS

- A. Division of work is the responsibility of the Prime Contractor. Any scope of work described in the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described in the contract documents. The following division of responsibility is a guideline based on typical industry practice.
- B. Definitions:
1. "Electrical Contractor" as referred to herein refers to the Contractors listed in Division 26 of this Specification.
 2. "Electrical Contractor" shall also refer to the Contractor listed in Division 27 of this specification when the "Suggested Matrix of Scope Responsibility" indicates the work shall be provided by the EC. Refer to the Contract Documents for the "Suggested Matrix of Scope Responsibility".
 3. "Technology Contractor" as referred to herein refers to the Contractors listed in Division 27 of this Specification.
 4. Low Voltage Technology Wiring: The wiring (less than 120VAC) associated with the Technology Systems, used for analog and/or digital signals between equipment.
 5. Telecommunications/Technology Rough-in: Relates specifically to the backboxes, necessary plaster rings and other miscellaneous hardware required for the installation and mounting of the telecommunications/technology outlet. Rough-in shall include conduit from the information outlet backbox to above the lay-in ceiling. Where surface mounted backboxes are required, conduit shall be routed to above the lay-in ceiling.
- C. General:
1. The purpose of these specifications is to outline typical Electrical and Technology Contractor's work responsibilities as related to technology systems including telecommunications rough-in, audio/visual systems rough-in, conduit, power wiring, and low voltage communications and technology wiring. The prime contractor is responsible for all divisions of work.

2. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals are approved. Therefore, only known wiring, conduits, raceways, and electrical power as related to such items, is shown on the technology drawings. Other wiring, conduits, raceways, junction boxes, and electrical power not shown on the technology drawings but required for the successful operation of the systems shall be the responsibility of the Technology Contractor and included in the Contractor's bid.
3. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of technology systems, the final installation shall not begin until a coordination meeting between the Electrical Contractor and the Technology Contractor has convened to determine the exact location and requirements of the installation.
4. Where the Electrical Contractor is required to install cable tray that will contain low voltage technology wiring, the installation shall not begin until the Technology Contractor has completed a coordination review of the cable tray shop drawing.
5. This Contractor shall establish electrical and technology utility elevations prior to fabrication and installation. The Technology Contractor shall cooperate with the Electrical Contractor and the determined elevations in accordance with the guidelines below. This Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
 - a. Lighting Fixtures
 - b. Gravity Flow Piping, including Steam and Condensate
 - c. Sheet Metal
 - d. Electrical Busduct
 - e. Cable Trays, including 12" access space
 - f. Sprinkler Piping and other Piping
 - g. Conduit and Wireway
 - h. Open Cabling

D. Electrical Contractor's Responsibility:

1. Assumes all responsibility for all required conduit and power connections when shown on the "Suggested Matrix of Scope Responsibility" to be provided by the Electrical Contractor.
2. Assumes all responsibility for providing and installing cable tray.
3. Responsible for Communications Systems grounding and bonding.
4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Technology Contractor's Responsibility:

1. Assumes all responsibility for the low voltage technology wiring of all systems, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being provided by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility."
3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined herein).

4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of technology equipment which is required to be bonded to the technology bonding system.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.4 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
 - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
 - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - d. Maintenance clearances and code-required dedicated space shall be included.
 - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
 - a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.

2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
 - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
 - a. Scale of drawings:
 - 1) General plans: 1/4 Inch = 1'-0" (minimum).
 - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
 - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
 - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
 - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.

4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in his/her bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
 - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
 - b. Potential layout changes shall be made to avoid additional access panels.
 - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
 - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
 - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain signoff of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.5 QUALITY ASSURANCE

A. Telecommunications Structured Cabling System Standards:

1. All work and equipment shall conform to the most current ratified version of the following published standards unless otherwise indicated that draft standards are to be followed:
 - a. ANSI/NECA/BICSI 568 - Standard for Installing Commercial Building Telecommunications Cabling
 - b. ANSI/TIA-568-C.0 - Generic Telecommunications Cabling for Customer Premises
 - 1) C.1 - Commercial Building Telecommunications Standard
 - 2) C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standard

- 3) C.3 - Optical Fiber Cabling Components Standard
 - 4) C.4 - Broadband Coaxial Cabling and Components Standard
- c. ANSI/TIA-569-C - Telecommunications Pathways and Spaces
 - d. ANSI/TIA-606-B - Administration Standard for Commercial Telecommunications Infrastructure
 - e. ANSI/TIA-607-B - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - f. ANSI/TIA-1152 - Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
 - g. ANSI/TIA/EIA-598-C - Optical Fiber Cable Color Coding
 - h. NFPA 70 (NEC) - National Electrical Code (Current Edition)
 - i. UL 444 - Standard for Safety for Communications Cable
- B. Refer to individual sections for additional Quality Assurance requirements.
- C. Qualifications:
1. Only products of reputable manufacturers as determined by the Architect/Engineer will be acceptable.
 2. The installing Contractor shall be certified by the manufacturer of the structured cabling system. Certification of Contractor shall have been in place for a minimum of one (1) year prior to bidding this project. Documentation of certification is required at the time of bid. Shop drawings will not be approved until proof of certification is submitted. Refer to the end of this specification section for certification documentation requirements.
 3. Each Contractor and their subcontractors shall employ only workers who are skilled in their respective trades and fully trained. All workers involved in the termination of cabling shall be individually certified by the manufacturer.
 4. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.
 5. The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical and copper structured cabling systems and have personnel adequately trained in the use of such tools and equipment.
 6. The Contractor must have a BICSI RCDD (Registered Communications Distribution Designer) or CNet CNIDP (Certified Network Infrastructure Design Professional) on-staff serving as a project manager. Project shop drawings and test reports shall be stamped by the RCDD or CNIDP.
 7. The Contractor shall obtain the services of a BICSI RCDD (Registered Communications Distribution Designer) or CNet CNIDP (Certified Network Infrastructure Design Professional) for the project. The RCDD or CNIDP shall perform the following tasks on the project:
 - a. Review contractor's submittals and stamp the submittals stating the submittals compliance with the contract documents.
 - b. Provide written and dated confirmation of an observation of the contractor's installation activities no less than every 2 weeks during the construction period.
 - c. Provide a final written and dated confirmation of a final construction review prior to testing.

- d. Review final testing of system and indication that the documented results or transmittal of the results stating the test results compliance with the contract documents.
8. The Contractor shall have certified BICSI installation technicians or CNet CNIT (Certified Network Infrastructure Technician) on staff to perform the following tasks on the project:
 - a. Act as the field superintendent or job foreman with the responsibility of monitoring the daily work of each technician.
 - b. Oversee all testing and termination of cabling.
9. The Contractor shall have certified BICSI Installer 2 or CNet CNCI (Certified Network Cabling Installer) on staff to perform the following tasks:
 - a. Installation and termination of copper cable.
 - b. Installation and termination of optical fiber.
10. A resume of qualification shall be submitted with the Contractor's bid indicating the following:
 - a. Documentation of certification of This Contractor by the proposed structured cabling system manufacturer as required at the end of this specification section.
 - b. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.
 - c. A list of test equipment proposed for use in verifying the installed integrity of copper and fiber optic systems on the project.
 - d. A technical resume of experience for the Contractor's project manager and on-site installation supervisor assigned to this project.
 - e. Resume and certification of the RCDD or CNIDP for the project as required by the form at the end of this specification section.
 - f. Resume and certification of the BICSI installation technician or CNet CNIT for the project.

D. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City of Evanston Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all published standards of State of Illinois .
3. In the event there are no local codes having jurisdiction over this job, the current issue of the National Electrical Code shall be followed.
4. If there is a discrepancy between the codes and regulations having jurisdiction over this installation, and these specifications, Architect/Engineer shall determine the method or equipment used.
5. If the Contractor notes, at the time of bidding, any parts of the drawings and specifications which are not in accordance with the applicable codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time to follow this procedure, he shall submit with the proposal, a separate price required to make the system shown on the drawings comply with the codes and regulations.

6. Verify the installation environment prior to purchasing or installing any cable. Cable installed in a plenum environment shall be appropriately rated. Bring all discrepancies between the contract documents and installation conditions to the attention of the Architect/Engineer prior to purchase or installation.
 7. All changes to the system made after the letting of the contract, in order to comply with the applicable codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.
- E. Permits, Fees, Taxes, Inspections:
1. Procure all applicable permits and licenses.
 2. Abide by all applicable laws, regulations, ordinances, and other rules of the State or Political Subdivision wherein the work is done, or as required by any duly constituted public authority.
 3. Pay all applicable charges for such permits or licenses that may be required.
 4. Pay all applicable fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
 5. Pay all charges arising out of required inspections due to codes, permits, licenses or as otherwise may be required by an authorized body.
 6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized independent agency/consultant.
 7. Pay any charges by the service provider related to the service or change in service to the project.
 8. All equipment and materials shall be as approved or listed by the following (unless approval or listing is not applicable to an item by all acceptable manufacturers):
 - a. Underwriters' Laboratories, Inc.
- F. Service Provider Requirements:
1. Secure from the telecommunications service provider all applicable requirements.
 2. Comply with all service provider requirements.
 3. The Owner shall make application for and pay for new telecommunications service equipment and installation. The Contractor shall coordinate schedule and requirements with the Owner and service provider.
- G. Examination of Drawings:
1. The drawings for the technology systems work are diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment etc., and the approximate sizes of equipment.
 2. Contractor shall determine the exact locations of equipment and the exact routing of cabling to best fit the layout of the job. Scaling of the drawings will not be sufficient or accurate for determining this layout. Where a specific route is required, such route will be indicated on the drawings.
 3. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.

4. If an item is either shown on the drawings, called for in the specifications or required for proper operation of the system, it shall be considered sufficient for including same in this contract.
5. The determination of quantities of material and equipment required shall be made by the Contractor from the drawings. Schedules on the drawings and in the specifications are completed as an aid to the Contractor but where discrepancies arise, the greater number shall govern.
6. Where words "provide", "install", or "furnish" are used on the drawings or in the specifications, it shall be taken to mean, to furnish, install and terminate completely ready for operation, the items mentioned.

H. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
4. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
5. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
6. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
7. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

I. Field Measurements:

1. Before ordering any materials, this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.
2. Field conditions that will result in telecommunications drops that exceed the length limitations identified in the contract documents shall be brought to the attention of the Architect/Engineer prior to installation. The cost of reworking cabling that is too long, that was not brought to the written attention of the Architect/Engineer will be borne entirely by the Contractor.
3. This Contractor shall provide the Architect/Engineer with written documentation of any cabling drops that will not be able to use the cable tray (where cable tray is available) due to the resulting cabling lengths. This documentation shall be submitted prior to installation and installation shall not commence until approved by the Architect/Engineer.

1.6 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

Referenced Specification Section	Submittal Item	Coordination Drawings
27 05 03	Through Penetration Firestopping	
27 05 26	Communications Bonding	
27 05 28	Interior Communications Pathways	Yes
27 05 43	Exterior Communications Pathways	Yes
27 05 53	Identification and Administration	
27 11 00	Communication Equipment Rooms	Yes
27 13 00	Backbone Cabling Requirements	
27 13 43.53	Television Distribution System	
27 15 00	Horizontal Cabling Requirements	
27 17 10	Testing	
27 41 00	Professional Audio Video System	Yes

- B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:
 - a. Project title and number
 - b. Contractor's name and address
 - c. Description of items submitted and relevant specification number
 - d. Notations of deviations from the contract documents
 - e. Other pertinent data
2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
 - a. Date
 - b. Project title and number
 - c. Architect/Engineer
 - d. Contractor and subcontractors' names and addresses
 - e. Supplier and manufacturer's names and addresses
 - f. Description of item submitted (using project nomenclature) and relevant specification number
 - g. Notations of deviations from the contract documents
 - h. Other pertinent data
 - i. Provide space for Contractor's review stamps
3. Composition:
 - a. Submittals shall be submitted using specification sections and the project nomenclature for each item.

- b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
 - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
 4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
 5. Contractor's Approval Stamp:
 - a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
 - b. Unstamped submittals will be rejected.
 - c. The Contractor shall provide proof of RCDD or CNIDP review on the submittal.
 - d. The Contractor's review shall include, but not be limited to, verification of the following:
 - 1) Only approved manufacturers are used.
 - 2) Addenda items have been incorporated.
 - 3) Catalog numbers and options match those specified.
 - 4) Performance data matches that specified.
 - 5) Electrical characteristics and loads match those specified.
 - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
 - 7) Dimensions and service clearances are suitable for the intended location.
 - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
 - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
 - e. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
 - f. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
 6. Submittal Identification and Markings:
 - a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.

- b. The Contractor shall clearly indicate the size, finish, material, etc.
 - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
 - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
 8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
 9. Reproduction of contract documents alone is not acceptable for submittals.
 10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
 11. Submittals not required by the contract documents may be returned without review.
 12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
 13. Submittals shall be reviewed and approved by the Architect/Engineer before releasing any equipment for manufacture or shipment.
 14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
 15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
 - a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.
 16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
3. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. Submittal file name: 27 XX XX.description.YYYYMMDD
 - b. Transmittal file name: 27 XX XX.description.YYYYMMDD
4. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.7 CHANGE ORDERS

- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.
- B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.
- C. Change order work shall not proceed until authorized.

1.8 EQUIPMENT SUPPLIERS' INSPECTION

- A. The following equipment shall not be placed in operation until a representative of the manufacturer has inspected the installation and certified that the equipment is properly installed and that the equipment is ready for operation:
 - 1. Firestopping, including mechanical firestop systems.

1.9 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

- A. Exercise care in transporting and handling to prevent damage to fixtures, equipment and materials.
- B. Store materials on the site to prevent damage.
- C. Keep fixtures, equipment and materials clean, dry and free from deleterious conditions.

1.10 NETWORK / INTERNET CONNECTED EQUIPMENT

- A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.11 WARRANTY

- A. At a minimum, provide a one (1) year warranty for all equipment, materials, and workmanship. Individual specifications sections within Division 27 may require additional warranty requirements for specific equipment or systems.
- B. The warranty period for the entire installation described in this Division of the specifications shall commence on the date of substantial completion unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner or their representative.

- C. Warranty requirements shall extend to correction, without cost to the final user, of all work and/or equipment found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from such defects or nonconformance with contract documents exclusive of repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

1.12 INSURANCE

- A. Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

1.13 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required.
- B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meets all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors. The Architect/Engineer shall make the final determination of whether a product is equivalent.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor bears full responsibility for the unnamed manufacturers equipment adequately meeting the intent of design. The Architect/Engineer may reject manufacturer at time of shop drawing submittal. The Contractor assumes all costs incurred by other trades on the project as a result of changes necessary to accommodate the offered material, equipment or installation method.
- D. Should this Contractor be unable to secure approval from the Architect/Engineer for other unnamed manufacturers as outlined above, this Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder. Should a voluntary alternate material be accepted, This Contractor shall assume all costs that may be incurred as a result of using the offered material, article or equipment necessitating extra expense on This Contractor or on the part of other Contractors whose work is affected.

PART 2 - PRODUCTS

2.1 CABLE JACKET RATING

- A. This project does not require all cable jackets to carry a plenum rating.

2.2 Refer to individual sections.

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Installation of all conduit and cabling shall comply with Sections 26 05 33 and 26 05 13. Additional conduit requirements described within this Division shall be supplemental to the requirement described in Section 26 0533. Should conflicts exist between the two Divisions the more stringent (more expensive material and labor) condition shall prevail until bidding addendum or construction clarification or RFI can be submitted and responded to. In no case shall the Contractor carry the least stringent condition in the pricing.
- B. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.
- C. The Contractor shall be responsible for identifying and reporting to the Architect/Engineer any existing conditions including but not limited to damage to walls, flooring, ceiling and furnishings prior to start of work. All damage to interior spaces caused by this Contractor shall be repaired at this Contractor's expense to pre-existing conditions, including final colors and finishes.
- D. All cables and devices installed in damp or wet locations, including any underground or underslab location, shall be listed as suitable for use in such environments. Follow manufacturer's recommended installation practices for installing cables and devices in damp or wet locations. Any cable or device that fails as a result of being installed in a damp or wet location shall be replaced at the Contractor's expense.

3.3 FIELD QUALITY CONTROL

- A. General:
1. Refer to specific Division 27 sections for further requirements.
 2. The Contractor shall conduct all tests required and applicable to the work both during and after construction of the work.

3. The necessary instruments and materials required to conduct or make the tests shall be supplied by the Contractor who shall also supply competent personnel for making the tests who has been schooled in the proper testing techniques.
4. In the event the results obtained in the tests are not satisfactory, This Contractor shall make such adjustments, replacements and changes as are necessary and shall then repeat the test or tests which disclose faulty or defective work or equipment, and shall make such additional tests as the Architect/Engineer or code enforcing agency deems necessary.
5. All communications cable tests that fail, including those due to excessive cabling lengths, shall be remedied by the Contractor without cost to the project.

B. Protection of cable from foreign materials:

1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.
2. Application of foreign materials of any kind on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

3.4 PROJECT CLOSEOUT

- A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.
- B. Final Jobsite Observation:
 1. The Architect/Engineer will not perform a final jobsite observation until the project is ready. This is not dictated by schedule, but rather by completeness of the project.
 2. Refer to the end of this specification section for a "STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION."
 3. The Contractor shall sign this form and return it to the Architect/Engineer so that the final observation can commence.
- C. Before final payment will be authorized, this Contractor must have completed the following:
 1. Submitted operation and maintenance manuals to the Architect/Engineer for review.

2. Submitted bound copies of approved shop drawings.
3. Record documents including edited drawings and specifications accurately reflecting field conditions, inclusive of all project revisions, change orders, and modifications.
4. Submitted a report stating the instructions given to the Owner's representative complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representative as having received the instructions.
5. Submitted testing reports for all systems requiring final testing as described herein.
6. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site; submit receipt to Architect/Engineer prior to final payment being approved.

3.5 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. O&M file name: O&M.div27.contractor.YYYYMMDD
 - b. Transmittal file name: O&Mtransmittal.div27.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of warranties.
6. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
7. Dimensional drawings of equipment.
8. Capacities and utility consumption of equipment.
9. Detailed parts lists with lists of suppliers.
10. Operating procedures for each system.
11. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
12. Repair procedures for major components.
13. List of lubricants in all equipment and recommended frequency of lubrication.
14. Instruction books, cards, and manuals furnished with the equipment.

3.6 INSTRUCTING THE OWNER'S REPRESENTATIVE

- A. Adequately instruct the Owner's designated representative or representatives in the maintenance, care, and operation of the complete systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representative or representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.
- D. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.
- E. The Architect/Engineer shall be notified of the time and place for the verbal instructions to be given to the Owner's representative so that their representative can be present if desirable.
- F. Refer to the individual specification sections for minimum hours of instruction time for each system.
- G. Operating Instructions:

1. The Contractor is responsible for all instructions to the Owner and/or Owner's operating staff on the Communications Systems.
2. If the Contractor does not have Engineers and/or Technicians on staff who can adequately provide the required instructions on system operation, performance, troubleshooting, care and maintenance, they shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.7 SYSTEM STARTING AND ADJUSTING

- A. The Communications Systems included in the construction documents are to be complete and operating systems. The Architect/Engineer will make periodic job site observations during the construction period. The system start-up, testing, configuration, and satisfactory system performance is the responsibility of the Contractor. This shall include all calibration and adjustments of electrical equipment controls, equipment settings, software configuration, troubleshooting and verification of software, and final adjustments that may be required.
- B. All operating conditions and control sequences shall be simulated and tested during the start-up period.
- C. The Contractor, subcontractors, and equipment suppliers are expected to have skilled technicians to ensure that the system performs as designed. If the Architect/Engineer is requested to visit the job site for the purpose of trouble shooting, assisting in the satisfactory start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period through no fault of the design; the Contractor shall reimburse the Owner on a time and material basis for services rendered at the Architect/Engineer's standard hourly rates in effect at the time the services are requested. The Contractor shall be responsible for making payment to the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.8 RECORD DOCUMENTS

- A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.
- B. Mark specifications to indicate approved substitutions, change orders, and actual equipment and materials used.
- C. This Contractor shall maintain at the job site, a separate and complete set of technology drawings which shall be clearly and permanently marked and noted in complete detail any changes made to the location and arrangement of equipment or made to the Technology Systems and wiring as a result of building construction conditions or as a result of instructions from the Architect or Engineer. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should This Contractor fail to complete Record Documents as required by this contract, This Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.

- D. Record actual routing of all conduits sized 2" or larger.
- E. The above record of changes shall be made available for the Architect and Engineer's examination during any regular work time.
- F. Upon completion of the job, and before final payment is made, This Contractor shall give the marked-up drawings to the Architect/Engineer.

3.9 ADJUST AND CLEAN

- A. Contractor shall thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.
- B. Contractor shall clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from equipment.
- C. Contractor shall remove all rubbish, debris, etc., accumulated during the Contractor's operations from the premises.

3.10 CONSTRUCTION WASTE MANAGEMENT

- A. This Contractor shall comply with all construction and demolition waste disposal and recycling requirements outlined in LEED MRc2: Construction Waste Management (follow latest edition at the time of bidding or as referenced in these specifications).
 - 1. This Contractor shall coordinate with the General Contractor to develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on-site or co-mingled.
 - 2. The Contractor shall track waste disposal and recycling efforts throughout the construction process for all materials associated with this Contractor's scope of work. The Contractor shall provide this information to the General Contractor so that it can be incorporated with similar information from all other contractors for the project.
 - a. Calculations for waste and recycled material can be done by weight or volume, but they must be consistent throughout the project. The Contractor shall coordinate with the General Contractor to establish the preferred calculation method and report the results accordingly.
 - 3. At a minimum, 50% of the construction and demolition debris for this project must be recycled or salvaged.

STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION

To assist the contractor in a timely close-out of the project, it is crucial that the final jobsite observation is not conducted prior to the project being ready. The contractor is required to review the completion status of the project at the time the observation is scheduled. This review, and the subsequent submittal of this form to the Architect/Engineer, shall indicate the contractor's agreement that the area of the project being requested for final observation is ready as defined below. The following list represents the degree of completeness required prior to requesting a final observation:

1. All cabling pathways (cable tray, ladder rack, conduit sleeves, etc.) are installed and all cabling has been pulled through them.
2. All mechanical firestop products are installed and all other penetrations have been sealed.
3. All telecommunications jacks are installed in the faceplates.
4. All telecommunications cabling is pulled and at least 75% of all jacks have been terminated at the jack and at the telecom room.
5. Telecommunications testing is in progress and at least 25% of testing has been completed.
6. Telecommunications labeling has been provided on at least 25% of each type of component requiring a label.
7. All telecommunications related grounding is complete.
8. All Audio/Visual components, cabling and control systems are installed, programmed and operational.
9. All overhead or integrated paging systems, including speakers, back boxes, cabling, and power supplies, and all headend equipment is installed, programmed and operational.
10. All CCTV cameras, mounts, cabling and all headend equipment are installed, programmed and operational.
11. All access control system equipment, including card readers, conduits, cabling, electronic locks, controllers and all headend equipment, is installed, programmed and operational.

Prime Contractor: _____ By: _____

Requested Observation Date _____ Today's Date: _____

Contractor shall sign this readiness statement and transmit to Architect/Engineer at least 10 days prior to the requested date of observation.

It is understood that if the Architect/Engineer finds that the project is not complete as defined above and that the final jobsite observation cannot be completed on the requested date, the Architect/Engineer will return to the site at a later date. All additional visits to the site for the purposes of completing the final observation will be billed T&M to the Contractor at our standard hourly rates, including travel expenses or the contractor's retainage may be deducted for the same amount.

TELECOMMUNICATIONS - PROOF OF CERTIFICATION

There are specific Contractor qualification requirements for this project as defined in Section 27 0500, which may include Manufacturer Certification and RCDD or CNIDP credentials. This Proof of Certification document, and the supporting documentation require herein, is required to be submitted at the time of bid to

show compliance with the requirements of 27 05 00.

Statement of Compliance:

The named Contractor's base bid is a structured cabling solution from the connectivity manufacturer .
Named Contractor is trained and certified, under the named manufacturer's formal certification program to provide and install all materials and work required by this project. Further, said Contractor is authorized, by the named manufacturer, to offer all product, labor and system assurance warranties required for this project by these contract documents.

The certification of this named manufacturer is valid, current and in effect as of the bid day of this project, the _____ day of _____, 20____.

The named Contractor is not employing any other sub-contractor on the telecommunications portion of this project that does not also meet this certification requirement.

Contractor Company Name: _____

Authorized Representative: (print) _____

Date: _____

Manufacturer Certification Number (if any): _____

If this project requires RCDD certification, complete the following:

RCDD or CNIDP Name: _____

RCDD #: _____ Expiration: _____

Submit the following with the bid:

This form.

Proof of Manufacturer Certification indicated above.

Proof of RCDD or CNIDP status.

END OF SECTION

SECTION 27 0503 - THROUGH PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 REFERENCES

- A. UL 263 - Fire Tests of Building Construction and Materials
- B. UL 723 - Surface Burning Characteristics of Building Materials
- C. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
- D. UL 2079 - Tests for Fire Resistance of Building Joint Systems
- E. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
- F. Intertek / Warnock Hersey - Directory of Listed Products
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- H. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
- I. HCAI - Health Care Access and Information (California)
- J. The Building Officials and Code Administrators National Building Code
 - K. 1997 Uniform Building Code
 - L. Wisconsin Administrative Code
 - M. 2015 International Building Code
 - N. NFPA 5000 – Building Construction Safety Code

1.2 SUBMITTALS

- A. Submit under provisions of Section 27 0500.
- B. Submit Firestopping Installers Certification for all installers on the project.
- C. Shop Drawings: Submit for each condition requiring firestopping. Include descriptions of the specific penetrating item, actual wall/floor construction, manufacturer's installation instructions, and UL or Intertek / Warnock Hersey Assembly number.
- D. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:
 - 1. Types of penetrating items.

2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.
3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.

E. Maintain a notebook on the job site at all times that contains copies of approved submittals for all through penetration firestopping to be installed. Notebook shall be made available to the Authority Having Jurisdiction at their request and turned over to the Owner at the end of construction as part of the O&M Manuals.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.
- B. Install material prior to expiration of product shelf life.

1.4 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
 1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
 2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
- B. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
- C. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- D. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

1.5 MEETINGS

- A. Pre-installation meeting: A pre-installation meeting shall be scheduled and shall include the General Contractor, all Subcontractors associated with the installation of systems penetrating fire barriers, Firestopping Manufacturer's Representative, and the Owner.
 1. Review foreseeable methods related to firestopping work.

2. Tour representative areas where firestopping is to be installed; inspect and discuss each type of condition and each type of substrate that will be encountered, and preparation to be performed by other trades.

1.6 WARRANTY

- A. Provide one year warranty on parts and labor.
- B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.
 1. 3M; Fire Protection Products Division
 2. Specified Technologies Inc. (S.T.I.)

2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

- A. Provide materials and systems classified by or listed by Intertek / Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.
- B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.
- C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.
- D. Firestopping systems for plumbing and wet pipe sprinkler piping shall be moisture resistant.
- E. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.
- F. Provide firestopping systems allowing continuous insulation for all insulated pipes.
- G. Provide firestopping systems classified by UL or listed by Intertek / Warnock Hersey for penetrations through all fire rated construction. Firestopping systems shall be selected from the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory Category XHEZ based on substrate construction and penetrating item size and material and shall fall within the range of numbers listed:

<u>Penetrating Item</u>	<u>UL System No.</u>
-------------------------	----------------------

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	FC 0000-0999*
Metallic Pipe or Conduit	FC 1000-1999
Non-Metallic Pipe or Conduit	FC 2000-2999
Electrical Cables	FC 3000-3999
Cable Trays	FC 4000-4999
Insulated Pipes	FC 5000-5999
Bus Duct and Misc. Electrical	FC 6000-6999
Duct without Damper and Misc. Mechanical	FC 7000-7999
Multiple Penetrations	FC 8000-8999
*Alternate method of firestopping is patching opening to match original rated construction.	

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	WL 0000-0999*
Metallic Pipe or Conduit	WL 1000-1999
Non-Metallic Pipe or Conduit	WL 2000-2999
Electrical Cables	WL 3000-3999
Cable Trays	WL 4000-4999
Insulated Pipes	WL 5000-5999
Bus Duct and Misc. Electrical	WL 6000-6999
Duct without Damper and Misc. Mechanical	WL 7000-7999
Multiple Penetrations	WL 8000-8999
*Alternate method of firestopping is patching opening to match original rated construction.	

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	CAJ 0000-0999*
Metallic Pipe or Conduit	CAJ 1000-1999
Non-Metallic Pipe or Conduit	CAJ 2000-2999
Electrical Cables	CAJ 3000-3999
Cable Trays	CAJ 4000-4999
Insulated Pipes	CAJ 5000-5999
Bus Duct and Misc. Electrical	CAJ 6000-6999
Duct without Damper and Misc. Mechanical	CAJ 7000-7999
Multiple Penetrations	CAJ 8000-8999
*Alternate method of firestopping is patching opening to match original rated construction.	

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.
- B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.
- C. Surfaces to which sealing materials are to be installed must meet the selected UL or Intertek / Warnock Hersey system substrate criteria.
- D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

3.2 INSTALLATION

- A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Intertek / Warnock Hersey listed firestopping system is installed.
- B. Install penetration seal materials in accordance with printed instructions of the UL or Intertek / Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.
- C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

3.3 CLEANING AND PROTECTING

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

3.4 IDENTIFICATION

- A. Provide and install labels adjacent to each firestopping location. Label shall be provided by the firestop system supplier and contain the following information in a contrasting color:
 - 1. The words "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Firestop System Supplier; UL or listed by Intertek / Warnock Hersey system number; date installed; contractor name and phone number; manufacturer's representative name, address, and phone number.

3.5 INSPECTION

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.
- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.
- D. The contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the contractor and witnessed by the Architect/Engineer and manufacturer's factory representative. The Architect/Engineer shall have sole discretion of which firestop system installations will be reviewed. The contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the Architect/Engineer's discretion and the contractor's expense.

END OF SECTION

SECTION 27 0526 - COMMUNICATIONS BONDING

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 0533 - Conduit and Boxes
- B. Section 26 0536 - Cable Trays
- C. Section 26 0513 - Wire and Cable
- D. Section 26 0526 - Grounding and Bonding
- E. Section 26 4100 - Lightning Protection Systems
- F. Section 27 0500 - Basic Communications Systems Requirements
- G. Section 27 0503 - Through Penetration Firestopping
- H. Section 27 1100 - Communication Equipment Rooms
- I. Section 27 0528 - Interior Communication Pathways
- J. Section 27 0553 - Identification and Administration

1.2 QUALITY ASSURANCE

- A. Refer to Section 27 0500 for relevant standards.
- B. Communications bonding system component, device, equipment, and material manufacturer(s) shall have a minimum of five (5) years documented experience in the manufacture of communications bonding products.
- C. The entire installation shall comply with all applicable electrical codes, safety codes, and standards. All applicable components, devices, equipment, and material shall be listed by Underwriters' Laboratories, Inc.

1.3 REFERENCES

- A. ANSI/IEEE 1100 - Recommended Practice for Power and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems
- B. ANSI/TIA/EIA 568-C - Commercial Building Telecommunications Cabling Standard
- C. ANSI/TIA/EIA 569-A - Commercial Building Standard for Telecommunications Pathways and Spaces

- D. ANSI/TIA/EIA 606 - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
 - E. ANSI/TIA/EIA 758 - Customer Owned Outside Plant
 - F. ANSI-J-STD-607-A - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - G. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements
 - H. IEEE 837 - IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding
 - I. NFPA 70 - National Electrical Code
 - J. NFPA 780 - Standard for the Installation of Lightning Protection Systems
 - K. UL 96 - Lightning Protection Components
 - L. UL 96A - Installation Requirements for Lightning Protection Systems
 - M. UL 467 - Grounding and Bonding Equipment
- 1.4 SUBMITTALS
- A. Submit product data and shop drawings under provisions of Section 27 0500 and Division 1.
 - B. Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:
 - 1. Compliance with each requirement of these documents. The submittal shall acknowledge each requirement of this section, item-by-item, including construction, materials, ratings, and all other parameters identified in Part 2 - Products.
 - 2. Manufacturer's installation instructions indicating application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
 - C. Provide CAD-generated, project-specific system shop drawings as follows:
 - 1. Provide a system block diagram indicating system configuration, system components, interconnection between components, and conductor routing. The diagram shall clearly indicate all wiring and connections required in the system. When multiple devices or pieces of equipment are required in the exact same configuration (e.g., multiple identical equipment racks or sections of ladder tray), the diagram may show one device and refer to the others as "typical" of the device shown. The diagram shall list room numbers where system equipment will be located.
 - 2. Installation details for all system components.
 - D. Provide system checkout test procedure to be performed at acceptance.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the site under the provisions of Section 27 0500.
- B. Store and protect products under the provisions of Section 27 0500.
- C. Contractor shall exercise care to prevent corrosion of any products prior to installation. Corroded products shall not be acceptable for use on this project.

1.6 SYSTEM DESCRIPTION

- A. This section describes the requirements for the furnishing, installation, adjusting, and testing of a complete turnkey communications bonding system, including connection to the electrical ground grid.
- B. Performance Statement: This specification section and the accompanying drawings are performance based, describing the minimum material quality, required features, operational requirements, and performance of the system. These documents do not convey every wire that must be installed, every equipment connection that must be made, or every feature and function that must be configured. Based on the equipment constraints described and the performance required of the system as presented in these documents, the Contractor is solely responsible for determining all components, devices, equipment, wiring, connections, and terminations required for a complete and operational system that provides the required performance.
- C. This document describes the major components of the system. All additional hardware, subassemblies, supporting equipment, and other miscellaneous equipment required for complete, proper system installation and operation shall be provided by the Contractor.
- D. Basic System Requirements:
 - 1. A complete communications bonding infrastructure is required for this project. Refer to the drawings and the requirements of ANSI-J-STD-607-A and NFPA 70 for complete information.
 - 2. The bonding system shall include, but not be limited to, the following major components:
 - a. Bonding Conductor for Telecommunications (BCT)
 - b. Telecommunications Main Grounding Busbar (TMGB)
 - c. Telecommunications Bonding Backbone (TBB)
 - d. Telecommunications Grounding Busbar(s) (TGB)
 - e. Rack mount Telecommunications Grounding Busbar(s)
 - f. Bonding Conductor(s) (BC)
 - g. Bonding Connectors
 - h. Bonding system labeling and administration as defined in Section 27 0553.

1.7 PROJECT RECORD DOCUMENTS

- A. Submit documents under the provisions of Section 27 0500.
- B. Provide final system block diagram showing any deviations from approved shop drawing submittal.

- C. Provide floor plans that document the following:
 - 1. Actual locations of system components, devices, and equipment.
 - 2. Actual conductor routing.
 - 3. Actual system component, device, equipment, and conductor labels.
 - D. Provide statement that system checkout test, as outlined in the approved shop drawing submittal, is complete and test results were satisfactory.
 - E. Complete all operation and maintenance manuals as described below.
- 1.8 OPERATION AND MAINTENANCE DATA
- A. Submit under provisions of Section 27 0500.
 - B. Submitted data shall include:
 - 1. Approved shop drawings.
 - 2. Descriptions of recommended system maintenance procedures, including:
 - a. Inspection
 - b. Periodic preventive maintenance
 - c. Fault diagnosis
 - d. Repair or replacement of defective components

PART 2 - PRODUCTS

2.1 BONDING CONDUCTORS

- A. Bare Copper:
 - 1. Annealed uncoated stranded conductor.
 - 2. Minimum size 6 AWG.
- B. Insulated Copper:
 - 1. Annealed uncoated stranded conductor.
 - 2. Insulation:
 - a. PVC insulation with nylon outer jacket.
 - b. Rated at 600 volts.
 - c. Green.
 - 3. Minimum size 6 AWG.
- C. All bonding conductors shall be listed and recognized by a nationally recognized testing laboratory as being suitable for the intended purpose and for installation in the space in which they are installed.

D. Bonding Conductor Sizing:

1. All communications bonding system conductors shall be sized by length as follows:

Length Linear ft (m)	Size (AWG)
Less than 13 (4)	6
14 - 20 (4 - 6)	4
21 - 26 (6 - 8)	3
27 - 33 (8 - 10)	2
34 - 41 (10 - 13)	1
42 - 52 (13 - 16)	1/0
53 - 66 (16 - 20)	2/0
Greater than 66 (20)	3/0

2. The BCT shall be the same size as the TBB or larger.

2.2 BONDING CONNECTORS

A. Acceptable Types:

1. Two-hole compression lug
2. Exothermic weld
3. Irreversible compression

B. Connectors shall be provided in kit form and selected per manufacturer's written instructions.

C. Connectors shall comply with IEEE 837 and UL 467 and be listed for use for specific types, sizes, and combinations of conductors and connected items.

2.3 GROUNDING BUSBAR (TMGB AND TGB)

A. Features:

1. Wall-mount configuration.
2. Listed and recognized by a nationally recognized testing laboratory as being suitable for intended purpose.
3. Hole patterns compliant with BICSI recommendations and ANSI-J-STD-607-A standards.
4. Pre-drilled holes.
5. Integral insulators.
6. Stainless steel offset mounting brackets.

B. Specifications:

1. Material: Electrolytic tough pitch copper bar with tin plating.
2. Minimum Dimensions: 1/4" thick x 4" high x 12" long.
 - a. Increase dimensions and/or quantity furnished and installed as required to accommodate all terminations required by the project, plus 20% spare capacity.

3. Hole pattern shall include:

- a. A minimum of 15 sets of 5/16" holes, 5/8" on center, to accommodate "A" spaced 2-hole compression lugs.
- b. A minimum of three (3) sets of 7/16" holes, 1" on center, to accommodate "C" spaced 2-hole compression lugs.

2.4 RACK-MOUNT TELECOMMUNICATIONS GROUNDING BUSBAR

A. Features:

1. Listed and recognized by a nationally recognized testing laboratory as being suitable for intended purpose.
2. Predrilled holes.
3. Mounts in a standard 19" equipment rack.

B. Specifications:

1. Material: Electrolytic tough pitch copper bar with tin plating.
2. Minimum Dimensions: 3/16" thick x 3/4" high x 19" long.
 - a. Increase dimensions and/or quantity furnished and installed as required to accommodate all terminations required by the project, plus 20% spare capacity.
3. Hole pattern shall include:
 - a. A minimum of eight (8) 6-32 tapped lug mounting holes on 1" centers.
 - b. A minimum of two (2) pairs of 5/16" diameter holes spaced 3/4" apart.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Bonding Requirements:

1. The communications bonding system shall be a complete system. Contractor shall furnish and install all necessary miscellaneous components, devices, equipment, material, and hardware, including, but not limited to, lock washers, paint-piercing washers, hex nuts, compression lugs, insulators, mounting screws, lugs, etc., to provide a complete system.
2. A licensed electrician shall perform all bonding.
3. Comply with the manufacturer's instructions and recommendations for installation of all products.

B. Main Cross Connect and Service Entrance Room Bonding Requirements:

1. Locate the TMGB in the service entrance room unless otherwise noted on the drawings.
2. The location of the TMGB shall be the shortest practical distance from the telecommunications primary lightning protection devices.

3. Bond the telecommunications primary protectors to the TMGB. Maintain a minimum 1 foot separation of the bonding conductor from all DC power cables, switchboard cable, and high frequency cable.
 4. In service entrance rooms where the entrance pathway contains an isolation gap, the pathway on the facility side of the gap shall be bonded to the TMGB.
- C. Where the service entrance cable contains a shield, the shield(s) shall be bonded to the TMGB using manufacturer-approved hardware.
- D. Telecommunications Main Ground Bar (TMGB) Requirements:
1. Install TMGB such that it is insulated from its support with a minimum 2" standoff.
 2. Bond the TMGB to the electrical service ground via the BCT.
 - a. A minimum of 1 foot separation shall be maintained between the BCT and any DC power cables, switchboard cable, or high frequency cables.
 3. Where backbone or horizontal cabling contains a shield, the shield(s) shall be bonded to the TMGB.
 4. TMGB shall be bonded to all electrical panels located in the same room or space as the TMGB or in an immediately adjacent space within 20 linear feet of the TMGB. TMGB shall be bonded to all electrical panels providing electrical power to communications equipment located in the same room or space as the TMGB.
 5. TMGB shall be bonded to accessible metallic building structure located within the same room or space as the TMGB.
 6. All metallic continuous cable pathways, including, but not limited to, cable trays, basket trays, ladder racks, raceways, conduits, conduit sleeves, and fire-rated cable pathway devices, located within the same room or space as the TMGB, shall be bonded to the TMGB.
 7. All metallic communications equipment, including, but not limited to, cable pair protectors, surge suppressors, cross-connect frames, patch panels, equipment cabinets, etc., located within the same room or space as the TMGB, shall be bonded to the TMGB.
- E. Telecommunications Ground Bar (TGB) Requirements:
1. Provide a TGB in each telecommunications equipment room.
 2. Install TGB such that it is insulated from its support with a minimum 2" standoff.
 3. Bond each TGB to the TMGB via the TBB.
 - a. A minimum of 1 foot separation shall be maintained between the TBB and any DC power cables, switchboard cable, or high frequency cables.
 4. Where horizontal cabling contains a shield, the shield(s) shall be bonded to the TGB.
 5. TGBs shall be bonded to accessible metallic building structure located within the same room or space as the TGBs.
 6. TGBs shall be bonded to all electrical panels located in the same room or space as the TGB or in an immediately adjacent space within 20 linear feet of the TGB. TGBs shall be bonded to all electrical panels providing electrical power to communications equipment located in the same room or space as the TGB.

7. All metallic continuous cable pathways, including, but not limited to, cable trays, basket trays, ladder racks, raceways, conduits, conduit sleeves, and fire-rated cable pathway devices, located within the same room or space as the TGB, shall be bonded to the TGB.
 8. All metallic communications equipment, including, but not limited to, cable pair protectors, surge suppressors, cross-connect frames, patch panels, equipment cabinets, etc., located within the same room or space as the TGB, shall be bonded to the TGB.
- F. Rack-mount Telecommunications Ground Bar Requirements (RTGB):
1. Provide a rack-mount telecommunications ground bar in each equipment rack.
 2. Install RTGB such that it is electrically bonded to the rack. Where necessary, remove paint and/or use paint-piercing washers to provide proper electrical bond between RTGB and equipment rack.
 3. Bond each RTGB to the TGB via a BC.
 4. If more than one (1) RTGB is provided within the same room or space, they shall all be bonded together via a BC.
 5. Where horizontal cabling containing a shield is terminated on rack-mounted termination hardware, the shield(s) shall be bonded to the RTGB.
 6. All contractor-furnished and/or contractor-installed metallic communications equipment, including, but not limited to patch panels, fiber optic distribution enclosures, splice enclosures, active electronics, uninterruptible power supplies, etc., mounted within the same equipment rack as the RTGB, shall be bonded to the RTGB. Where necessary, remove paint and/or use paint-piercing washers to provide proper electrical bond between equipment rack and installed metallic communications equipment. Active electronics and uninterruptible power supplies shall be bonded to the RTGB via a dedicated BC for each device.
- G. Metallic Interior Communication Pathway Bonding Requirements:
1. All metallic interior continuous communication cable pathways, including, but not limited to, conduit, conduit sleeves, fire-rated cable pathway devices, cable tray, basket tray, and ladder rack, shall be bonded to the communications bonding system.
- H. Bonding Connection Requirements:
1. Make all connections in accessible locations to facilitate future inspection and maintenance.
 2. Communications bonding system connections shall be made using exothermic welding, two-hole compression lugs, or other irreversible compression-type connections. The use of 1-hole lugs is prohibited, except for connections to a rack-mount telecommunications ground bar. Connection hardware shall be listed for grounding and bonding. Sheet metal screws shall not be used to make communications bonding system connections.
 3. Thoroughly clean conductors before installing lugs and connectors.
 4. Install and tighten all connectors in accordance with manufacturer's instructions, using the appropriate purpose-designed tool(s) recommended by the manufacturer for that purpose. Exercise care not to tighten connectors beyond manufacturer's recommendations.
 5. Where necessary, remove paint and/or use paint-piercing washers to provide proper electrical bond at all connections.
 6. All bonding connections shall be coated in anti-oxidant joint compound that is purpose-designed and purpose-manufactured for that use. Anti-oxidant joint compound shall be applied in accordance with manufacturer's recommendations and instructions.

7. All installed connectors on conductors installed in damp locations shall be sealed with dielectric grease and then covered with heat shrink tubing to protect against moisture ingress. Applied heat shrink tubing shall overlap conductor's outer jacket a minimum of four (4) inches past connector and be installed in accordance with manufacturer's recommendations and instructions.

3.2 FIELD QUALITY CONTROL

- A. Field inspection and testing shall be performed under provisions of Section 27 0500.
- B. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product from a reputable manufacturer that meets the requirements of the specifications.
- C. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the contract documents.

3.3 ADJUSTING

- A. Adjust work under provisions of Section 27 0500.
- B. Contractor shall make any and all adjustments to the communications bonding system necessary to ensure that the installed system meets all requirements listed herein. Modifications necessary to comply with listed requirements or to provide specified performance shall be completed by the Contractor at no additional cost to the Owner.

3.4 TESTING

- A. Test installed system under provisions of Section 27 1710.
- B. Measure and document resistance to ground at TMGB, each TGB, each RTGB, and each electrical distribution panel bonded to the TMGB or a TGB.
 1. Measurements shall be made 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.
 2. Measured resistance to ground at TMGB, each TGB, and each RTGB must not exceed 1 ohm.
 3. Under no circumstances shall any point in the communications bonding system have a lower resistance to ground than that of nearby electrical distribution system components that it is bonded to.
- C. Measure and document voltage between screen of installed and terminated ScTP, FTP, and/or SSTP horizontal cables and electrical ground of electrical outlet(s) serving the information outlet location area.
 1. The voltage between the screen and the ground wire shall not exceed 1.0 V rms, and 1.0 V dc for any installed and terminated ScTP, FTP, and/or SSTP horizontal cables.

- D. Include measurement documentation in test data submitted at completion of project under provisions of Section 27 1710.

3.5 SYSTEM TRAINING

- A. All labor and materials required for on-site system training shall be provided. Training shall be conducted at the project site using the project equipment.
 - 1. Provide two week's advanced notice of training to the Owner and Architect/Engineer.
 - 2. The Architect/Engineer shall be presented with the option to attend the training.
 - 3. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.
- B. At a minimum, the following training shall be conducted:
 - 1. A course detailing the system functions and operations that a technical user will encounter. Provide training on all aspects of using the system, including making new bonding connections to the TMGB, TGB, or RTGB. Provide training on all recommended inspection, maintenance, and repair procedures for the system.
- C. Minimum on-site training times shall be:
 - 1. Technical user: Four hours.

END OF SECTION

SECTION 27 0528 - INTERIOR COMMUNICATION PATHWAYS

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 0533 - Conduit and Boxes
- B. Section 27 0500 - Basic Communications Systems Requirements
- C. Section 27 0526 - Communications Bonding

1.2 QUALITY ASSURANCE

- A. Refer to Section 27 0500 for requirements.

1.3 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code
- B. NEMA VE 2-2000 - Cable Tray Installation Guidelines

1.4 SUBMITTALS

- A. Under the provisions of Section 27 0500 and Division 1, prior to the start of work the Contractor shall submit:
 - 1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
- B. Coordination Drawings:
 - 1. Include cable tray and conduit sleeve layout in composite electronic coordination files. Refer to Section 27 0500 for coordination drawing requirements.

1.5 DRAWINGS

- A. The drawings, which constitute a part of these specifications, indicate the general route of the wire mesh support systems, conduit, sleeves, etc. Data presented on these drawings is as accurate as preliminary surveys and planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification of all dimensions, routing, etc., is required.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Refer to Section 26 05 33 for conduit requirements for this project.

2.2 CABLE HANGERS AND SUPPORTS

- A. Provide a non-continuous cable support system suitable for use with open cable.
- B. Cable Hooks:
 - 1. Construction: Flat bottom design with a minimum cable bearing surface of 1-5/8". Hooks shall have 90-degree radius edges.
 - 2. All cable hook mounting hardware shall be recessed to prevent damage to cable during installation. Installed cabling shall be secured using a cable latch retainer that shall be removable and reusable.
 - 3. Finish: Pre-galvanized steel, ASTM A653 suitable for general duty use zinc plated steel, ASTM B633 SC3 suitable for heavy duty use. Provide stainless steel AISI Type 304 hooks for corrosive locations.
- C. Cable Hangers:
 - 1. Adjustable, non-continuous cable support slings for use with low voltage cabling.
 - 2. Steel and woven laminate construction, rated for indoor non-corrosive use. Laminate material shall be suitable for use in plenum environments.
 - 3. Sling length shall be adjustable to a capacity of 425 4-pair UTP cables.
 - 4. Cabling hanger load limit shall be 100 lbs per foot.
 - 5. Manufacturer:
 - a. Erico Caddy
 - b. CableCat CAT425
 - c. Arlington Fittings T1 Series
 - d. Or approved equal.

2.3 INNERDUCT - CORRUGATED

- A. Fabricated from self-extinguishing high-impact polyvinyl chloride (PVC), orange in color.
- B. Fittings and accessories fabricated from same material as conduit and usable with rigid nonmetallic conduit.
- C. Solvent-cement type joints as recommended by manufacturer.
- D. Inside diameter not less than that of rigid steel conduit.
- E. Dielectric strength a minimum of 400 volts per mil.
- F. Corrugated wall construction.
- G. Pull rope pre-installed by manufacturer.
- H. Innerduct installed within buildings (not including riser paths) or utility tunnels shall meet all the above General requirements plus:

1. Be fabricated of flame-retardant materials (plenum rated) suitable for installation in such environments.
 2. Meet or exceed all requirements for flame resistant duct as required by Bellcore TR-NWT-000356 (Section 4.33).
- I. Innerduct installed within building riser shafts shall meet all the above general requirements plus:
1. Be fabricated of flame-retardant materials suitable for installation in such environment.
- J. Meet or exceed all requirements for flame propagation as specified by test method UL-1666 and referenced by the National Electrical Code (NEC) Section 770-53 for listed optical fiber raceways being installed in vertical runs in a shaft between floors.

PART 3 - EXECUTION

3.1 INNER DUCT INSTALLATION REQUIREMENTS

- A. Inner duct shall be riser or plenum rated as required by the installation environment. At minimum, inner duct should extend to the ladder rack above the termination enclosure at system endpoints. Where not installed in a continuous length, inner duct segments should be spliced using couplings designed for that purpose.
- B. All exposed inner duct is to be labeled at 35-foot intervals with tags indicating ownership, the cable type (e.g., "Fiber Optic Cable") and the cables it contains (e.g., MA-CS or FS-CS).
- C. Where exposed, fiber optic cable shall be installed in protective inner duct.
- D. Contractor shall determine optimum size and quantity to satisfy the requirements of the installation and to ensure that the mechanical limitations, including minimum bend radius of the cable, are considered.
- E. The inner duct should extend into the termination enclosure at system endpoints.
- F. Where not installed in a continuous length, inner duct segments should be spliced using couplings designed for that purpose.

3.2 CABLE HOOK SUPPORT SYSTEM

- A. In areas where cabling is not supported by cable tray, ladder rack, enclosed wireway or installed in conduit, such cabling shall be supported by an approved cable hook support system.

3.3 ATTACHMENT TO METAL DECKING

- A. Where supports for cable trays and cable hook systems attach to metal roof decking, excluding concrete on metal decking, do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center. This 25-lb. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

City of Evanston
Evanston Animal Shelter
Holabird & Root, LLC Project No. 16015

Issued for Bid / Permit
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END OF SECTION

SECTION 27 0543 - EXTERIOR COMMUNICATION PATHWAYS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section describes the products and execution requirements relating to furnishing and installing exterior racks, ladders, conduits, sleeves, innerduct, etc. for an exterior cabling plant.

1.2 QUALITY ASSURANCE

- A. Refer to Section 27 0500 for relevant standards.
- B. Precast Manufacturer (if applicable): Company specializing in precast concrete structures with three (3) years documented experience.

1.3 REFERENCES

- A. Section 27 0500 - Basic Communications Systems Requirements.
- B. AASHTO HS-20 - Standard Specification for Highway Bridges.
- C. ANSI/ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- D. ANSI/ASTM A569 - Steel, Sheet and Strip, Carbon (0.15 Maximum Percent), Hot-Rolled, Commercial Quality.
- E. ASTM A48 - Gray Iron Castings.
- F. ASTM A123 - Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strips.

1.4 SUBMITTALS

- A. Under the provisions of Section 27 0500 and Division 1, prior to the start of work the Contractor shall submit:
 - 1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
- B. Manhole submittal (if applicable): Indicate material specifications, dimensions, capacities, size and location of openings, reinforcing details, and accessory locations.
 - 1. Provide product data for manhole accessories.
- C. Submit shop drawings and product data under provisions of Section 27 0500.
- D. Submit manufacturer's installation instructions under provisions of Section 27 0500.

E. Coordination Drawings:

1. Include manholes, hand holes, and conduits 1.5" and larger in coordination files. Include all in-floor and underfloor conduit in coordination files. Refer to Section 27 0500 for coordination drawing requirements.

1.5 REGULATORY REQUIREMENTS

- A. Equipment and material shall be UL (Underwriters Laboratory) listed and labeled.

PART 2 - PRODUCTS

2.1 OUTSIDE PLANT CONDUIT

A. High-Density Polyethylene (HDPE) Conduit:

1. Minimum Size: 2 inches, unless noted otherwise.
2. Acceptable Manufacturers:
 - a. Carlon
3. Materials used for the manufacture of polyethylene pipe and fittings shall be extra high molecular weight, high-density polyethylene resin. The material shall be listed by PPI (Plastic Pipe Institute) and shall meet the following resin properties:

ASTM Test	Description	Values HDPE
D-1505	Density g/CM 3	Less than 0.941
D-1238	Melt Index, g/10 min Condition E	Greater than 0.55 grams/10 min.
D-638	Tensile Strength at yield (psi)	3000 min.
D-1693	Environmental Stress Crack Resistance Condition B, F 20	96 hrs.
D-790	Flexural Modulus, MPa (psi)	Less than 80,000
D-746	Brittleness Temperature	-75°C Max

4. Fitting and Conduit Bodies:
 - a. For All Other Types of Installation: Coupler must provide a watertight connection. The tensile strength of coupled pipe must be greater than 1,000 lbs.
 - b. E-loc type couplings are not acceptable in any situations.
 - c. Acceptable Manufacturers:
 - 1) Carlon

2.2 HAND-HOLES

A. Dimensions:

1. XX. As indicated on the drawings.

B. Requirements:

1. Includes polymer concrete cover.

C. Acceptable Manufacturers

1. Quazite

SIZE	OD	ID
1"	1.375" (Max.)	1.0" (Min.)
1-1/4"	1.67" (Max.)	1.25" (Min.)
1-1/2"	2.0" (Max.)	1.5" (Min.)

2.3 UNDERGROUND WARNING TAPE

- A. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, compounded for direct-burial service.
- B. Overall Thickness: 5 mils.
- C. Foil Core Thickness: 0.35 mil.
- D. Orange colored tape 3-wide with 1-inch high black letters permanently imprinted with "CAUTION "" BURIED COMMUNICATIONS LINE BELOW". Printing on tape shall be permanent and shall not be damaged by burial operations.
- E. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- F. Comply with ANSI Z535.1 through ANSI Z535.5.

PART 3 - EXECUTION

3.1 INSTALLATION - DUCTBANK

- A. Make duct bank installations and penetrations through foundation walls watertight.
- B. Top of duct banks shall be a minimum of 24 inches below grade, unless otherwise indicated on drawings.
- C. Assemble duct banks using non-magnetic saddles, spacers and separators. Position separators to provide 3-inch minimum separation between the outer surfaces of the ducts.
- D. Transition from non-metallic to galvanized rigid steel conduit where duct banks enter buildings, manholes, and hand-holes.

- E. Where ducts enter structures such as manholes, hand-holes, pullboxes and buildings, terminate the ducts in suitable end bells.
- F. Slope duct runs for drainage toward manholes and away from buildings with a slope of approximately 3-inches per 100 feet.
- G. After completion of the duct bank and prior to pulling cable, pull a mandrel, not less than 12 inches long and with a cross section approximately 1/4 inch less than the inside cross section of the duct, through each duct. Then pull a rag swab or sponge through to make certain that no particles of earth, sand, or gravel have been left in the duct.
- H. Plug and seal empty spare ducts entering buildings and structures. Seal watertight all ducts in use entering buildings and structures.

3.2 INSTALLATION - HAND-HOLES

- A. Install gravel drainage bed a minimum of 6" depth below hand-hole using a minimum gravel size of 1 inch.
- B. Provide units and/or extensions as required by conduit depth for hand-hole cover to be flush with finished grade.
- C. Slope grade away from cover with a slope of approximately 1 inch in 3 feet.
- D. Conduit entry penetrations shall not exceed 25% of side wall area.

3.3 EXCAVATION, FILL, BACKFILL, COMPACTION

A. General:

- 1. The Contractor shall do all necessary excavating, securing, filling, backfilling, compacting, and restoration in connection with their work.

B. Excavation:

- 1. Excavations for trenches shall be excavated to proper dimensions to permit installation and inspection of work.
- 2. Where excavations are carried in error below indicated levels, thoroughly compacted sand-gravel fill, shall be placed in such excess excavations.
- 3. Excavations shall be protected against frost action and freezing.
- 4. Care shall be exercised in excavating so as to not damage surrounding structures, equipment, and buried utilities. In no case shall any major structural footing or foundation be undermined.
- 5. Excavation shall be performed in all ground characteristics, including rock, if encountered. Each bidder shall visit the premises and determine, by actual observations, borings, or other means, the nature of the soil conditions. The cost of all such inspections, borings, etc., shall be borne by the bidder.
- 6. In the case where the trench is excavated in rock, a compacted bed with a depth of 3" (minimum) of sand and gravel shall be used to support the conduit unless masonry cradles or encasements are used.

7. Where satisfactory bearing soil is not found at the indicated levels, the Architect/Engineer or their representative shall be notified immediately and no further work shall be done until further instructions are given.
 8. Mechanical excavation of the trench to line and grade of the conduit, unless otherwise indicated on the drawings.
- C. Dewatering:
1. The Contractor shall be responsible for the furnishing, installation, operation and removal of all dewatering pumps and lines necessary to keep the excavation free of water at all times.
- D. Underground Obstructions:
1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found by calling 811. The Contractor is responsible for obtaining all utility locates for all trades on the project to determine obstructions indicated. The Contractor shall use great care in installing in the vicinity of underground obstruction.
- E. Fill and Backfilling:
1. No rubbish or waste material shall be permitted in excavations for trench fill and backfill.
 2. The Contractor shall provide the necessary sand for backfilling.
 3. Dispose of the excess excavated earth as directed.
 4. Soils for backfill shall be suitable for required stability and compaction, clean and free from perishable materials, frozen earth, debris or earth with an exceptionally high void content, and free from stones greater than 4 inches in diameter. Under no circumstances shall water be permitted to rise in unbackfilled trenches after installation has been placed.
 5. All trenches shall be backfilled immediately after installation of conduit, unless other protection is directed.
 6. All conduit shall be laid on a compacted bed of sand at least 3" deep. Backfill around the conduit with sand, spread in 6" layers, then compact each layer.
 7. Use sand for backfill up to grade for all conduit located under building slabs or paved areas. Native soil materials may be used as backfill if approved by the Geotechnical Engineer. All other conduit shall have sand backfill to 6" above the top of the conduit.
 8. The backfilling above the sand shall be placed in uniform layers not exceeding 6" in depth. Each layer shall be placed, then carefully and uniformly tamped, so as to eliminate the possibility of lateral or vertical displacement.
 9. Install a warning tape approximately 12 inches below finished grade over all underground duct banks. The identifying warning tape shall be as specified above.
 10. Where the fill and backfilling will ultimately be under a building, floor or paving, each layer of fill shall be compacted to 95% of the maximum density as determined by AASHTO Designation T-99 or ASTM Designation D-698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content as determined by AASHTO T-99 or ASTM D-698 test.
 11. After backfilling of trenches, no superficial loads shall be placed on the exposed surface of the backfill until a period of 48 hours has elapsed.

3.4 RESTORATION REQUIREMENTS

- A. Where soil and sod has been removed, it shall be replaced as soon as possible after backfilling is completed. All areas disturbed by work shall be restored to their original condition. The restoration shall include any necessary topsoiling, fertilizing, liming, seeding, or mulching,

END OF SECTION

SECTION 27 0553 - IDENTIFICATION AND ADMINISTRATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section describes the identification and administration requirements relating to the structured cabling system and its termination components and related subsystems.
- B. Administration of structured cabling system, utilizing identifiers, records, record linkages and presentation.

1.2 RELATED WORK

- A. Section 27 0500 - Basic Communications Systems Requirements

1.3 QUALITY ASSURANCE

- A. Refer to Section 27 0500 for relevant standards.

1.4 SUBMITTALS

- A. Under the provisions of Section 27 0500 and Division 1, prior to the start of work the Contractor shall submit:
 - 1. Documentation of labeling scheme.

PART 2 - PRODUCTS

2.1 ADMINISTRATION

- A. Administrative System Outline:
 - 1. Telecommunications Ground Bar:
 - a. Bonding conductor records, space records.

2.2 LABELING

- A. Adhesive labels shall meet the requirements of UL 969 (Ref D-16) for legibility, defacement and adhesion. Exposure requirements of UL 969 for indoor and outdoor (as applicable) use shall be met.
- B. Insert labels shall meet the requirements of UL 969 for legibility, defacement and general exposure.

- C. Labeling shall be consistent for all common elements in the project. This consistency shall include label size, color, typeface and attachment method.
- D. Labels incorporating bar codes shall be either Code 39 conforming to USS-39 or Code 128 conforming to USS-128.
1. All Code 39 bar codes shall have a ratio between 2.5:1 and 3.0:1. Provide a minimum "quiet zone" of 0.25" on each side of the bar code.
 2. A descriptive label for reading by personnel shall be provided with any bar code. Bar codes by themselves are not acceptable.
- E. Color Code: Observe the following requirements for color coding:
1. Labels on each end of a cable shall be the same color for each termination.
 2. Labels for cross-connects shall be two different colors at each termination fields, representative of the color of that field.
 3. Green (Pantone 353C) shall be used for the termination point of network connection on the facility side of the demarc.
 4. Purple (Pantone 264C) shall be used to identify the termination of cables from common equipment (PBX, computers, LANS, etc.)
 5. White shall be used to identify the first-level backbone termination in the main cross-connect.
 6. Gray (Pantone 422C) shall be used to identify the second-level backbone termination in the main cross-connect.
 7. Blue (Pantone 291C) shall be used to identify the termination of station cabling at the telecommunications closet and/or equipment room end of the cable.
 8. Brown (Pantone 465C) shall be used to identify the termination of the interbuilding backbone cable terminations.
 9. Yellow (Pantone 101C) shall be used to identify the termination of auxiliary circuits, alarms, maintenance, security, etc.
 10. Red (Pantone 184C) shall be used to identify the termination of key telephone systems.
 11. In facilities that do not contain a main cross-connect, the color white may be used to identify second-level backbone terminations.
- F. Tag all , CAT 6, and optical fiber cables at both the Communications Equipment Room and the information outlets using the following alphanumeric labeling system:
1. (Telecom Room Number) - (Patch Panel Letter) - (Patch Panel Port Number).
 2. "Telecom Room Number" shall be as indicated on the drawings.
 3. "Patch Panel Letter" shall start with 'A' for the top modular patch panel, increasing sequentially from top to bottom across the equipment rack.
 4. "Patch Panel Port Number" shall start with '1' for the upper left port in each modular patch panel, increasing sequentially from left to right and top to bottom across the modular patch panel face.
 5. Example #1: MC/1-A3 indicates the third modular patch panel port in modular patch panel 'A' in Main Equipment Room (MC/1).
 6. Example #2: HC/2-C39 indicates the thirty-ninth modular patch panel port in modular patch panel C in Horizontal Cross-Connect room (HC/2).

2.3 DOCUMENTATION/AS-BUILTS/RECORDS

A. General:

1. Upon completion of the installation, the Contractor shall submit as-builts per the requirements of Section 27 0500 and Division 1. Documentation shall include the items detailed in the subsections below.
2. All documentation, including hard copy and electronic forms shall become the property of the Owner.

B. Record Drawings:

1. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons and drawing conventions used shall be consistent throughout all documentation provided.

PART 3 - EXECUTION

3.1 IDENTIFICATION AND LABELING

A. Cable Labeling: Backbone and horizontal cables shall be labeled at each end.

1. Provide additional cable labeling at each manhole and pull box.

B. Termination Hardware Labeling:

1. An identifier shall be provided at each termination hardware location or its label.

C. Grounding/Bonding Labeling:

1. The TMGB shall be labeled "TMGB." There shall be only one TMGB in the facility.
2. Label all TBB conductors connecting to the TMGB with a unique label, located at both ends of the TBB.
3. Each TGB shall be labeled with a unique label.
4. All TBB conductors connecting to the TGB shall be labeled uniquely at each end of the cable.

END OF SECTION

SECTION 27 1100 - COMMUNICATION EQUIPMENT ROOMS (CER)

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section describes the products and execution requirements related to furnishing and installing equipment for communication equipment rooms.

1.2 RELATED WORK

- A. Section 27 0500 - Basic Communications Systems Requirements
- B. Section 27 0526 - Communications Bonding
- C. Section 27 0528 - Interior Communication Pathways
- D. Section 27 1500 - Horizontal Cabling Requirements

1.3 SUBMITTALS

- A. Under the provisions of Section 27 0500 and Division 1, prior to the start of work the Contractor shall submit:
 - 1. Manufacturer's data covering all products including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
- B. Coordination Drawings:
 - 1. Include ladder racking, equipment racks, cable tray and conduit sleeve layout in composite electronic coordination files. Refer to Section 27 0500 for coordination drawing requirements.

PART 2 - PRODUCTS

2.1 EQUIPMENT GROUNDING

- A. Refer to specification section 27 0526 for grounding requirements.
- B. All equipment required to be grounded shall be provided with a grounding lug suitable for termination of the specified size electrode conductor.

2.2 EQUIPMENT RACKS AND CABINETS

- A. Where identified on the drawings in Communication Equipment Rooms, equipment racks and/or equipment cabinets shall be furnished and installed by the Contractor to house cable termination components (e.g., copper, optical fiber, coax) and network electronics.
- B. The equipment rack shall conform to the following requirements:
1. Standard TIA/EIA 19" Floor Rack:
 - a. Equipment rack shall be 84" in height, self-supporting and provide a useable mounting height of 45 rack units (RU) (1 RU = 1 3/4").
 - b. Equipment rack shall be double side drilled and tapped to accept 12-24 screws. Uprights shall also be drilled on back to accept cable brackets, clamps, power strip(s), etc. Hole pattern on rack front shall be per TIA/EIA specifications (5/8"-5/8"-1/2"). Hole pattern on the rear shall be at 3" intervals to accept cable brackets.
 - c. Equipment racks shall be provided with a supply of spare screws (minimum of 24).
 - d. Equipment racks shall be provided with a ground bar and #6 AWG ground lug.
 - e. Provide all mounting hardware and accessories as required for a complete installation.

2.3 CABLE MANAGEMENT - VERTICAL AND HORIZONTAL

- A. Equipment Racks:
1. Equipment racks shall be equipped with vertical and horizontal cable management hardware in the form of rings and guides. Racks shall incorporate vertical and horizontal covers, to allow an orderly, hidden, routing of copper, optical fiber, and coax jumpers from the modular patch panels and/or 110-type termination blocks to the customer provided network electronics. Vertical and horizontal cable management hardware shall be as follows:
 - a. Horizontal cable management hardware shall be 16 gauge cold rolled steel construction with six (6) pass-thru holes and seven (7) front-mounted 3.5" steel rod D-rings. Provide with cover designed to conceal and protect cable.
 - b. At a minimum, horizontal cable management hardware shall be positioned above and below (a) each grouping of two rows of jacks on modular patch panels, and (b) above and below each optical fiber patch panel and (c) each grouping of two rows of F-type connectors on coax patch panels.
 - c. Vertical cable management hardware shall provide for cable routing on front and rear of each rack and be 14" deep x 6" wide (minimum). Where multiple equipment racks are to be installed, this hardware shall be mounted between the uprights of adjacent equipment racks. Equipment rack uprights and the spacers shall be secured together per manufacturer's recommendations. Provide with cover designed to conceal and protect cable.
 2. Each equipment rack shall be supplied with a minimum of 12 releasable (e.g., "hook and loop") cable support ties.

3. Where cable termination hardware is wall-mounted, the Contractor shall be responsible for establishing a cable pathway for jumpers routed from the equipment rack(s) to the wall. This shall be in the form of slotted ducts or troughs. Routing of jumpers via the overhead cable tray or ladder rack system is NOT acceptable. The proposed method shall be included in the submittals required by this document and shall be approved by the Architect/Engineer prior to installation.

2.4 PATCH PANELS

- A. Where identified on the drawings in Communication Equipment Rooms, modular patch panels shall be furnished and installed by the Contractor for termination of copper cable.
- B. Copper cabling shall be terminated in Communication Equipment Rooms on modular patch panels consisting of a modular connector system incorporating modular jacks meeting the specifications for the jacks detailed in Section 27 1500.
- C. The largest single modular patch panel configuration shall not exceed 48-Ports. Modular patch panels shall be fully populated (all ports occupied by jacks) and be provided in increments of no less than 12 jacks. High-density modular patch panels will not be accepted.
- D. The modular patch panel blocks shall have the ability to seat and cut eight (8) conductors (4 pairs) at a time and shall have the ability of terminating 22- through 26-gauge plastic insulated, solid and stranded copper conductors. Modular patch panel blocks shall be designed to maintain the cables' pair twists as closely as possible to the point of mechanical termination.
- E. Modular patch panels shall incorporate cable support and/or strain relief mechanisms to secure the horizontal cables at the termination block and to ensure that all manufacturers minimum bend radius specifications are adhered to.

2.5 OPTICAL FIBER PANELS

- A. All terminated optical fibers shall be mated to simplex LC-type couplings mounted on enclosed fiber distribution cabinets. Couplings shall be mounted on a panel that, in turn, snaps into the enclosure. The proposed enclosure shall be designed to accommodate a changing variety of connector types including SC, ST, Fixed Shroud Duplex (e.g., "FDDI Connector"), Biconic, FC, and MT-RJ by changing panels on which connector couplings are mounted.
- B. The fiber distribution cabinet shall be sized to accommodate the total fiber count to be installed at each location as defined in the specifications and drawings, including those not terminated (if applicable). Connector panels and connector couplings (sleeves, bulkheads, etc.) adequate to accommodate the number of fibers to be terminated shall be furnished and installed by the Contractor.
- C. The fiber distribution cabinet shall be an enclosed assembly affording protection to the cable subassemblies and to the terminated ends. The enclosures shall incorporate a hinged or retractable front cover designed to conceal and protect the optical fiber couplings, connectors, and cable.

- D. Access to the inside of the fiber distribution cabinet's enclosure during installation shall be from the front and/or rear. Panels that require any disassembly of the fiber distribution cabinet to gain entry will not be accepted.
- E. The fiber distribution cabinet's enclosure shall provide for strain relief of incoming optical fiber cables and shall incorporate radius control mechanisms to limit bending of the optical fiber to the manufacturer's recommended minimums or 1/2", whichever is larger.
- F. All fiber distribution cabinets shall provide protection to both the "facilities" and "user" side of the coupling. The fiber distribution cabinet's enclosure shall be configured to require front access only when patching. The incoming optical fiber cables (e.g., backbone, riser, horizontal, etc.) shall not be accessible from the patching area of the panel. The fiber distribution cabinet's enclosure shall provide a physical barrier to access such optical fiber cables.
- G. Where "Loose Buffered" cables are installed, the 250 μm coated optical fibers contained in these cables may be terminated either by (1) splicing of factory-terminated cable assemblies ("pigtailed") or (2) the use of a "fan-out" kit. In the latter approach, individual fibers are to be secured in a protective covering, an Aramid (e.g., Kevlar) reinforced tube for example, with connectors mated to the resulting assembly. In both instances, the proposed termination hardware shall incorporate a mechanism by which cable and subassemblies are secured to prevent damage. Splicing shall be by the "fusion" method. Individual splice loss shall not exceed 0.3 dB for multi-mode fibers. Direct termination of 250 μm coated optical fibers shall not be permitted.

2.6 OPTICAL FIBER COUPLERS/ADAPTERS

A. Optical Fiber Couplings (LCtype) (Multimode/Singlemode):

- 1. LC-type optical fiber couplings shall be snap-type with locking washer and nut.
- 2. LC-type optical fiber couplings shall incorporate domed zirconia ferrule and shall utilize a PC polish to ensure fiber-to-fiber physical contact for low loss and reflections.
- 3. LC-type optical fiber couplings shall accept 125-micron outside diameter multimode fiber.
- 4. The attenuation per mated pair shall not exceed 0.7 dB (individual) and 0.5 dB (average). Connectors shall sustain a minimum of 200 mating cycles per TIA/EIA-455-21 without violating specifications.
- 5. LC-type optical fiber couplings shall meet the following performance criteria:

Test Procedure	Maximum Attenuation Change
Cable Retention (FOTP-6)	0.2 dB
Durability (FOTP-21)	0.2 dB
Impact (FOTP-2)	0.2 dB
Thermal Shock (FOTP-3)	0.2 dB
Humidity (FOTP-5)	0.2 dB

- 6. Performance Requirements:
 - a. Length: 2 inches
 - b. Operating Temperature: -40 to 85 degrees C
- 7. Basis of Design:

- a. Hubbell

2.7 LADDER RACK

- A. Provide complete ladder rack system including metallic ladder rack, splice connectors, fastening hardware and other miscellaneous materials as required for a complete installation per manufacturer's recommendations.
- B. Tubing Style Ladder Rack:
 - 1. Rolled steel siderail stringer, minimum 1.5" stringer height, 9" spaced welded rungs.
 - 2. Steel shall meet the requirements of ASTM A1011 SS Grade 33.
- C. Ladder rack finish shall be flat black powder coat.

2.8 COPPER PATCH CORDS

- A. Modular Patch Panel:
 - 1. Provide Category 6 Category 6A copper patch cords for 50% of all assigned ports on the modular patch panel. Of these cords, 60% shall be 3' in length and 40% shall be 5' in length. These patch cords shall be the cross-connect between the network electronics and the horizontal RJ-45 modular patch panel. Copper patch cords shall be equipped with a 4-pair RJ-45 connector on each end.
 - 2. Refer to Section 27 1500 for cable and connector performance requirements.
 - 3. Patch cords shall not be made-up in the field.
 - 4. Basis of Design (Refer to 27 17 20 for Acceptable Manufacturers):
 - a. Hubbell HC Series

2.9 FIBER PATCH CORDS

- A. Optical Fiber Patch Cords (Multimode):
 - 1. Provide 50/125 mm multimode (MM) optical fiber utilizing tight buffer construction for 50% of all assigned ports on the fiber distribution cabinet. These patch cords shall be the cross-connect between the backbone fiber distribution cabinet and the Owner's network electronics (hub/switch). Optical fiber patch cords shall be equipped with a ceramic tipped LC-type connector on each end and shall be a minimum of 5 feet in length. Connector body shall be of materials similar to that used in the proposed couplings. Provide required lengths as determined on the plans.
 - 2. Channels shall be of equal length.
 - 3. Refer to Section 27 1500 for cable and connector performance requirements.
 - 4. Basis of Design (Refer to 27 17 20 for Acceptable Manufacturers):
 - a. Hubbell DFPC Series

2.10 DEMARCATION REQUIREMENTS

- A. Contractor shall coordinate all requirements for the demarcation point with the Owner's selected service provider.
- B. The Contractor shall not proceed with any installation without written communication with the Architect/Engineer should the service provider's requirements differ from the work shown on the contract documents.
- C. Refer to the drawings for further requirements.

PART 3 - EXECUTION

3.1 EQUIPMENT RACKS

- A. The Contractor shall bolt the rack to the floor as recommended by the manufacturer. Multiple racks shall be joined and the ground made common on each. The rack shall be stabilized by extending a brace to the wall. Alternately, overhead ladder rack by which the cabling accesses the equipment rack(s) may provide this function.
- B. A space between the rack upright and the wall (approximately 4") should be provided to allow for cabling in that area. The rear of the rack should be approximately 40" from the wall to allow for access by maintenance personnel. In all cases, a minimum of 40" workspace in front of the rack is also required. Locations where these guidelines cannot be followed should be brought to the attention of the Architect/Engineer for resolution prior to installation.
- C. Each rack shall be grounded to the Telecommunications Ground Bar (GND) using a #6 AWG (or larger) insulated stranded copper conductor (GREEN jacket) directly or via an adjacent grounded equipment rack. Refer to grounding requirements below.

3.2 LADDER RACK

- A. Provide support for ladder rack on 4 ft centers.
- B. Maintain a 1.5 safety factor on all load limits specified herein.
- C. Ladder rack support shall be by 5/8" diameter threaded rod when ceiling mounted. Ladder rack requiring wall mounting shall utilize accessories supplied by the ladder rack manufacturer specifically for the purpose of wall mounting ladder rack.

3.3 GROUNDING

- A. Provide a complete grounding system in accordance with the requirements of Section 27 0526.

3.4 CROSS CONNECT INSTALLATION

- A. Bend radius of cable shall not exceed 4 times the outside cable diameter or manufacturer's recommendation, whichever is less.

- B. Cables shall be neatly bundled and dressed to their respective panels and/or blocks. Each shall be fed by an individual bundle separated and dressed to the point of cable entrance into the rack and/or frame.
- C. The cable jacket shall be maintained as close as possible to the termination point.
- D. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that is visible without removing the bundle support.

3.5 OPTICAL FIBER TERMINATION

- A. All fiber slack shall be neatly coiled within fiber splice enclosures or splice trays. No slack loops shall be allowed external to the enclosure.
- B. Each cable shall be individually attached to the respective fiber enclosure by mechanical means. The cable strength member shall be securely attached to the cable strain relief bracket in the enclosure.
- C. Each cable shall be clearly labeled at the entrance to all enclosures.
- D. A maximum of 12 strands shall be spliced in any tray.

3.6 CONDUITS AND CABLE ROUTING

- A. Refer to Section 26 0533 for additional requirements.
- B. Where conduits enter a telecommunications room, conduits shall be terminated on the wall where shown on the contract documents. Conduits entering the room from the floor shall extend 3" above the floor slab 3" into the room below the raised floor.
- C. Where cabling rises vertically in a telecommunications rooms, provide vertical cable management to support the cabling from floor to ceiling level.
- D. All conduits shall be reamed and shall be installed with a nylon bushing.
- E. Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of 2" or less, maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter greater than 2", maintain a bend radius of at least 10 times the internal diameter.

END OF SECTION

SECTION 27 1343.53 - TELEVISION DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 4100 - Lightning Protection System
- B. Section 27 0500 - Basic Communications Requirements
- C. Section 27 0526 - Communications Bonding
- D. Section 27 1300 - Backbone Cabling Requirements
- E. Section 27 1500 - Horizontal Cabling Requirements

1.2 REFERENCES

- A. Applicable ANSI/SCTE Standards
- B. NFPA 70 - National Electrical Code

1.3 SUBMITTALS

- A. Shop Drawings: Indicate electrical characteristics and connection requirements. Show installation details, cable routing, head end device and tap values, and system configuration.
- B. Product Data: Provide showing electrical characteristics and connection requirements for each component.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.4 SYSTEM DESCRIPTION

- A. Premise cabling and associated head end equipment for broadband distribution of television signal to information outlet locations.

1.5 PERFORMANCE REQUIREMENTS

- A. Installed television distribution system shall provide broadband RF signal at each outlet with the following characteristics:
 - 1. Frequency range: 49 - 860 MHz
 - 2. Signal strength: +6 dB, \pm 3dB at all channels distributed
 - 3. Impedance: 75 Ohms

- B. Television distribution system shall provide discrete sub-band RF return functionality to route locally originated audio/video content signals to head end for distribution through system.
 - C. Local Origination Sources:
 - 1. LaserDisc #1 located in SC-MC-1 Telecom Room 42, distributed on Channel 37
 - 2. Video surveillance camera located at Door 1234, distributed on Channel 1
- 1.6 PROJECT RECORD DOCUMENTS
- A. Submit under provisions of Section 27 0500.
 - B. Record actual locations of head end equipment and devices, distribution equipment and devices, outlets, and cable routing.
- 1.7 OPERATION AND MAINTENANCE DATA
- A. Submit under provisions of Section 27 0500.
 - B. Operation Data: Instructions for setting and tuning channels.
 - C. Maintenance Data: Basic troubleshooting procedures.
- 1.8 QUALIFICATIONS
- A. Manufacturer: Company specializing in manufacturing the products specified in this section, with minimum three years documented experience, and with service facilities within 100.
 - B. Supplier: Authorized distributor of specified manufacturer with minimum three years documented experience.
 - C. Installer: Authorized installer of specified manufacturer, with service facilities within 100.
- 1.9 REGULATORY REQUIREMENTS
- A. Conform to requirements of NFPA 70.
 - B. Furnish products listed and classified by UL, suitable for purpose specified and indicated.
 - C. Conform to all applicable Federal Communications Commission requirements and requirements of the cable television service provider.
- 1.10 MAINTENANCE SERVICE
- A. Furnish service and maintenance of television system for one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 INDOOR WALL-MOUNTED BI-DIRECTIONAL BROADBAND RF DISTRIBUTION AMPLIFIER

- A. Impedance: 75 Ohm
- B. Frequency response
 - 1. Forward: 54 - 860 MHz
 - 2. Return: 5 - 36 MHz
- C. Return loss
 - 1. Input: \pm 16 dB
 - 2. Output: \pm 16 dB
- D. Gain control range: \pm 10 dB
- E. Maximum output: + 40 dBmV, +/- 1.5 dB flatness
- F. Noise at maximum output: \pm 8.5 dB
- G. Connectors: F-type female for input and output
- H. Field-configurable active or passive return
- I. Accepts plug-in equalizer and attenuator accessories
- J. 120-volt AC power supply
- K. Integral ground lug terminal
- L. Basis of design:
 - 1. Blonder Tongue BIDA 86A-43P

2.2 INDOOR BROADBAND RF SPLITTER

- A. Impedance: 75 Ohm
- B. Frequency response: 5 - 1000 MHz
- C. Number of output ports: 2, 3, 4, 6, and 8 port models
- D. Insertion loss (maximum at 1000 MHz):
 - 1. 2-port: 4.2 dB
 - 2. 3-port: 8 dB
 - 3. 4-port: 8.1 dB

4. 6-port: 11.3 dB
 5. 8-port: 12.2 dB
- E. Return loss: \geq 18 dB at 1000 MHz
- F. Isolation between outputs: \geq 21 dB
- G. Connectors: F-type female for input and outputs
- H. L-style configuration with connectors oriented perpendicular to backplane of device
- I. Integral ground lug terminal
- J. Integral mounting tabs
- K. Basis of design:
1. Blonder Tongue SCVS
- 2.3 INDOOR BROADBAND RF DIRECTIONAL COUPLER / TAP
- A. Impedance: 75 Ohm
- B. Frequency response: 5 - 1000 MHz
- C. Number of output ports: 2, 4, and 8 port models
- D. Tap values:
1. 2-port: 8, 11, 14, 17, 20, 23, 26, 29, and 32 dB models
 2. 4-port: 11, 14, 17, 20, 23, 26, 29, 32, and 35 dB models
 3. 8-port: 14, 17, 20, 23, 26, 29, 32, and 35 dB models
- E. Insertion loss, input to through output (maximum at 1000 MHz):
1. 2-port models
 - a. 8 dB model: 3.5 dB
 - b. 11 dB model: 3.0 dB
 - c. 14 dB model: 2.2 dB
 - d. 17 dB model: 1.8 dB
 - e. 23 dB model: 1.2 dB
 - f. 26 dB model: 1.2 dB
 - g. 29 dB model: 1.2 dB
 - h. 32 dB model: 1.2 dB
 2. 4-port model
 - a. 11 dB model: 4.4 dB
 - b. 14 dB model: 2.5 dB

- c. 17 dB model: 2.0 dB
- d. 20 dB model: 1.4 dB
- e. 23 dB model: 1.2 dB
- f. 26 dB model: 1.0 dB
- g. 29 dB model: 1.0 dB
- h. 32 dB model: 1.0 dB
- i. 35 dB model: 1.0 dB

3. 8-port model

- a. 14 dB model: 4.5 dB
- b. 17 dB model: 2.5 dB
- c. 20 dB model: 2.0 dB
- d. 23 dB model: 1.4 dB
- e. 26 dB model: 1.2 dB
- f. 29 dB model: 1.0 dB
- g. 32 dB model: 1.0 dB
- h. 35 dB model: 1.0 dB

F. Return loss: \geq 16 dB at 1000 MHz

G. Isolation between tap outputs: \geq 22 dB

H. Connectors: F-type female for input and outputs

I. L-style configuration with tap output connectors oriented perpendicular to backplane of device

J. Integral ground lug terminal

K. Basis of design:

- 1. Blonder Tongue SRT

2.4 BROADBAND RF COAXIAL CABLE

A. Refer to Section 27 1500 for RG-6 cable requirements

B. Refer to Section 27 1500 for RG-11 cable requirements

C. Refer to Section 27 1300 for .500 hardline cable requirements

2.5 COAXIAL CABLE CONNECTORS

A. RG-6 quad shield coaxial cable connector:

- 1. F-type male connector
- 2. Free-spinning sealed nut design
- 3. 360° radial compression
- 4. Shielding effectiveness \geq -80dB
- 5. SCTE-compliant seal to cable jacket

6. Basis of design:
 - a. Corning Gilbert GF-UR-6
 - B. RG-11 quad shield coaxial cable connector:
 1. F-type male connector
 2. Free-spinning sealed nut design
 3. 360° radial compression
 4. Shielding effectiveness ≥ -80dB
 5. Return Loss ≥ 30 dB
 6. Insertion Loss ≤ 0.08 dB
 7. SCTE-compliant seal to cable jacket
 8. Basis of design:
 - a. Corning Gilbert GAF-UR-11
- 2.6 75-OHM F-TYPE TERMINATOR
- A. Impedance: 75 Ohm
 - B. Connector: F-type male
 - C. Basis of design:
 1. Blonder Tongue BTF-TP

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all equipment in accordance with manufacturer's recommendations.
- B. Install and tighten all connectors in accordance with manufacturer's instructions, using the appropriate purpose-designed tools recommended by the manufacturer for that purpose. Exercise care not to tighten connectors beyond manufacturer's recommendations.
- C. Connect television service to distribution equipment in accordance with the cable television service provider's recommendations. Contractor shall coordinate all requirements with the television service provider prior to cable and equipment installation.
- D. Properly ground all television system components and wiring. Bond outdoor components to lightning protection system as close to the point of entrance as possible.
- E. All fittings on and connections to equipment installed outdoors shall be sealed with dielectric grease and then covered with heat shrink tubing to protect against weather and moisture ingress. Applied heat shrink tubing shall overlap cable's outer jacket a minimum of 4 inches past connector and be installed in accordance with manufacturer's instructions.

- F. All unused ports, including test ports on equipment, shall be terminated with a non-locking 75-Ohm terminator cap.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Prepare and start systems under provisions of Section 27 0500.
- B. Supervise final adjustments and tuning of system.

3.3 ADJUSTING

- A. Adjust work under provisions of Section 27 0500.
- B. Adjust work under supervision of manufacturer's field service personnel.
- C. Adjust each antenna using field strength meter to orient it for maximum signal reception on all channels.
- D. Adjust amplifier gain, slope, and other system adjustments to achieve specified output levels at each outlet.

3.4 TESTING

- A. Test installed cable under provisions of Section 27 1710.
- B. Measure delivered signal at each outlet to verify specified output levels and signal quality at each outlet.
- C. Document measured signal at each outlet and include in test data submitted at completion of project under provisions of Section 27 1710.

3.5 SYSTEM COMMISSIONING:

- A. The Contractor shall notify the Architect/Engineer and Owner prior to conducting final system commissioning.
- B. Contractors' tests shall be scheduled and documented in accordance with the commissioning requirements. Refer to Section 01 0900 - General Commissioning for additional information.
- C. System verification testing is part of the commissioning process. Verification testing shall be performed by the Contractor and witnessed and documented by the Commissioning Agent. Refer to Section 01 0900 - General Commissioning for system verification tests and commissioning requirements.
- D. Contractor shall demonstrate system performance of all equipment and adjust settings as directed by the Architect/Engineer and/or Owner.
 - 1. All system settings, options, and parameters shall be simulated and tested by the Contractor as part of the commissioning process.

3.6 SYSTEM TRAINING

- A. All labor and materials required for on-site system training shall be provided. Training shall be conducted at the project site using the project equipment.
 - 1. Provide two week's advanced notice of training to the Owner and Architect/Engineer.
 - 2. The Architect/Engineer shall be presented with the option to attend the training.
 - 3. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.

- B. At a minimum, the following training shall be conducted:
 - 1. User Manual: A course detailing the system functions and operations that a daily user will encounter.
 - 2. Technical User: Provide configuration training on all aspects of the system(s), including equipment and software.
 - 3. Maintenance User: Provide training on all aspects of physical maintenance of the systems, including cleaning of the displays, bulb changes, filter cleaning, and filter changing.

- C. Minimum on-site training times shall be:
 - 1. User Manual: One day.
 - 2. Technical user: One day.
 - 3. Maintenance user: One day.
 - 4. The Contractor shall include in his/her bid one (1) additional day of training each quarter for the 12-month period of the project warranty. The Contractor shall return to the site for additional follow-up training during this period.

END OF SECTION

SECTION 27 1500 - HORIZONTAL CABLING REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section describes the products and execution requirements relating to furnishing and installing horizontal communications cabling and termination components and related subsystems as part of a cabling plant. The cabling plant consists of copper cabling.

1.2 RELATED WORK

- A. Section 27 0500 - Basic Communications Systems Requirements
- B. Section 27 1720 - Structured Cabling System Warranty

1.3 QUALITY ASSURANCE

- A. Refer to Section 27 0500 for relevant standards and plenum or non-plenum cable requirements.
- B. The channel shall be required to meet the performance requirements indicated herein. The manufacturer shall warranty the performance of their system to the required performance (and not just to the Standard, should the required performance exceed the Standard).
- C. Specific components of the channel shall be required, at a minimum, to meet the Standard component requirements for that particular component.
- D. The installing contractor must be certified by the manufacturer of the structured cabling system.

1.4 SUBMITTALS

- A. Under the provisions of Section 27 0500 and Division 1, prior to the start of work the Contractor shall submit:
 - 1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
 - 2. Manufacturer's installation instructions.

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLE

A. CAT 6 Cable:

1. The horizontal cable requirements must be met, as well as the following channel requirements.
2. CAT 6 cable shall terminate on rack-mounted modular patch panels in their respective communication equipment room as indicated on the drawings.
3. Performance tests shall be conducted using swept frequency testing through 250 MHz for the channel. All numbers given are for a 4-connection channel. Discrete frequency testing results at 250 MHz is not acceptable.
4. Performance data shall be characterized as "Guaranteed Headroom" and shall be guaranteed by the manufacturer to perform at guaranteed margins over ANSI/TIA/EIA-568-C.2. Performance data that is not warranted by the manufacturer will not be considered.
5. The structured cabling and connectivity must be provided by the same company. For the purpose of this specification that shall mean that the cabling and connectivity must be marketed, branded, supported, warranted, and distributed by the same company. Specifically, ally or partnerships between cabling manufacturers and connectivity manufacturers do not meet this requirement unless otherwise listed in Section 27 1720 as an acceptable manufacturer. Specifically, products made by others through an OEM relationship are acceptable if the products are marketed, branded, supported, warranted, and distributed by the same company.
6. The 4-connector channel performance margins in the table below shall be guaranteed margins above ANSI/TIA/EIA-568-C.2:

Electrical Value (1 - 250 MHz)	Minimum Margin
Insertion Loss:	5%
NEXT:	3.0 dB
PS NEXT:	5.0 dB
ACR-F (ELFEXT):	4.0 dB
PS ACR-F (PS ELFEXT):	5.0 dB
Return Loss:	2 dB

7. The jacket color for CAT 6 cable shall be white for voice applications and blue for data applications.
8. Basis of Design:
 - a. Hubbell HC6R Series
 - b. Additional acceptable manufacturers:
 - 1) Panduit

B. CAT 6A Cable:

1. The horizontal cable requirements must be met, as well as the following channel requirements.
2. CAT 6A cable shall terminate on rack-mounted modular patch panels in their respective communication equipment room as indicated on the drawings.

3. Cable shall exceed transmission requirements listed in ANSI/TIA/EIA-568-C.2. Performance tests shall be conducted using swept frequency testing through 500 MHz for the channel. All numbers given are for a 4-connection channel. Discrete frequency testing results at 500 MHz is not acceptable.
4. Performance tests shall be conducted using swept frequency testing through 500 MHz for the channel. All numbers given are for a 4-connection channel. Discrete frequency testing results at 500 MHz is not acceptable.
5. Performance data shall be provided by third-party independent testing laboratories only. Testing data shall be submitted on the third-party testing laboratory letterhead. Test data will only be accepted if it displays testing as a channel. Electrical characteristics of the performance of the cable itself will not satisfy this requirement.
6. The structured cabling and connectivity may be provided by the same company. For the purpose of this specification that shall mean that the cabling and connectivity must be marketed, branded, supported, warranted, and distributed by the same company. Specifically, ally or partnerships between cabling manufacturers and connectivity manufacturers do not meet this requirement unless otherwise listed in Section 27 1720 as an acceptable manufacturer. Specifically, products made by others through an OEM relationship are acceptable if the products are marketed, branded, supported, warranted, and distributed by the same company.
7. The 4-connector channel performance margins in the table below shall be guaranteed margins above ANSI/TIA/EIA-568-C.2:

Electrical Value (1 - 500 MHz)	Minimum Margin
Insertion Loss:	3%
NEXT:	2 dB
PS NEXT:	3 dB
PSA NEXT:	3 dB
PSA NEXT (Average):	
ACR-F:	2 dB
PS ACR-F:	3 dB
PSA ACR-F:	3 dB
PSA ACR-F (Average):	3 dB
Return Loss:	2 dB

8. The jacket color for CAT 6A cable shall be blue for data applications.
9. Basis of Design:
 - a. Hubbell C6ASP Series
 - b. Additional acceptable manufacturers:
 - 1) Panduit

2.2 CONNECTORS/COUPLERS/ADAPTERS

- A. Refer to Section 27 1100 for requirements and 27 13 00 for requirements.

2.3 FACEPLATES/JACKS

- A. CAT 6 Jacks:

1. CAT 6 horizontal cable shall each be terminated at their designated work area location on RJ-45 modular jacks. These modular jack assemblies shall snap into a modular mounting frame. The combined modular jack assembly is referred to as an information outlet.
2. The same orientation and positioning of modular jacks shall be utilized throughout the installation. Prior to installation, the Contractor shall submit the proposed configuration for each information outlet type for review by the Architect/Engineer.
3. Information outlet faceplates shall incorporate recessed designation strips at the top and bottom of the frame for identifying labels. Designation strips shall be fitted with clear plastic covers.
4. Where standalone CAT 6 only modular jacks are identified, the information outlet faceplate shall be configured as to allow for the addition of one (1) additional modular jack (CAT 3, CAT 5E, or CAT 6) to be installed to supplement each such modular jack as defined by this project. The installation of these supplemental modular jacks is NOT part of this project.
5. Any unused modular jack positions on an information outlet faceplate shall be fitted with a removable blank inserted into the opening.
6. All modular jacks will be fitted with a dust cover. Modular jacks shall incorporate a dust cover that fits over and/or into the modular jack opening. The dust cover shall be designed to remain with the modular jack assembly when the modular jack is in use. No damage to the modular jack pinning shall result from insertion or removal of these covers. Dust covers that result in deformation of the modular jack pinning, will not be accepted.
7. The information outlet faceplate shall be constructed of high impact plastic (except where noted otherwise). The information outlet faceplate color shall:
 - a. Match the receptacle color used for other utilities in the building, or
 - b. When installed in surface raceway (if applicable), match the color of that raceway.
8. Different faceplate and frame designs for locations, which include optical fiber cabling relative to those, that terminate only copper cabling are acceptable. Information outlets that incorporate optical fiber shall be compliant with the above requirements plus:
 - a. Be a low-profile assembly.
 - b. Incorporate a mechanism for storage of cable and fiber slack needed for termination.
 - c. Position the optical fiber couplings to face downward or at a downward angle to prevent contamination.
 - d. Incorporate a shroud that protects the optical fiber couplings from impact damage.
9. All information outlets and the associated modular jacks shall be of the same manufacturer throughout the project.
10. The CAT 6 modular jacks shall be non-keyed 8-pin modular jacks.
11. The interface between the modular jack and the horizontal cable shall be a 110-type termination block or insulation displacement type contact. Termination components shall be designed to maintain the horizontal cable's pair twists as closely as possible to the point of mechanical termination.
12. CAT 6 modular jacks shall be pinned per TIA-568B.
13. CAT 6 termination hardware shall, as a minimum, meet all the mechanical and electrical performance requirements of the following standards:
 - a. ANSI/TIA/EIA-568-A-5
 - b. ANSI/TIA/EIA-568A

- c. ISO/IEC 11801
- d. IEC 603-7
- e. FCC PART 68 SUBPART F

14. The color for CAT 6 jacks shall be white for voice applications and blue for data applications. Alternately, a color-coded bezel or icon may be used to identify the CAT 6 modular jack.

B. Cat 6A Jacks:

1. CAT 6A horizontal cable shall each be terminated at its designated work area location on RJ-45 modular jacks. These modular jack assemblies shall snap into a modular mounting frame. The combined modular jack assembly is referred to as an information outlet.
2. The same orientation and positioning of modular jacks shall be utilized throughout the installation. Prior to installation, the Contractor shall submit the proposed configuration for each information outlet type for review by the Architect/Engineer.
3. Information outlet faceplates shall incorporate recessed designation strips at the top and bottom of the frame for identifying labels. Designation strips shall be fitted with clear plastic covers.
4. Any unused modular jack positions on an information outlet faceplate shall be fitted with a removable blank inserted into the opening.
5. All modular jacks will be fitted with a dust cover. Modular jacks shall incorporate a dust cover that fits over and/or into the modular jack opening. The dust cover shall be designed to remain with the modular jack assembly when the modular jack is in use. No damage to the modular jack pinning shall result from insertion or removal of these covers. Dust covers that result in deformation of the modular jack pinning, will not be accepted.
6. The information outlet faceplate shall be constructed of high impact plastic (except where noted otherwise). The information outlet faceplate color shall:
 - a. Match the receptacle color used for other utilities in the building, or
 - b. When installed in surface raceway (if applicable), match the color of that raceway.
7. Different faceplate and frame designs for locations, which include optical fiber cabling relative to those, that terminate only copper cabling are acceptable. Information outlets that incorporate optical fiber shall be compliant with the above requirements plus:
 - a. Be a low-profile assembly.
 - b. Incorporate a mechanism for storage of cable and fiber slack needed for termination.
 - c. Position the optical fiber couplings to face downward or at a downward angle to prevent contamination.
 - d. Incorporate a shroud that protects the optical fiber couplings from impact damage.
8. All information outlets and the associated modular jacks shall be of the same manufacturer throughout the project.
9. The CAT 6A modular jacks shall be non-keyed 8-pin modular jacks.
10. The interface between the modular jack and the horizontal cable shall be an angled insulation displacement type contact and shall provide separation for ANEXT suppression. Termination components shall be designed to maintain the horizontal cable's pair twists as closely as possible to the point of mechanical termination.
11. CAT 6A modular jacks shall be pinned per TIA-568B.

12. CAT 6A termination hardware shall, as a minimum, meet all the mechanical and electrical performance requirements of the following standards:
13. The color for CAT 6A jacks shall be blue for data applications. Alternately, a color-coded bezel or icon may be used to identify the CAT 6A modular jack.

2.4 RG-11 BROADBAND RF COAXIAL CABLE

A. Basic Construction:

1. Center conductor: 14 AWG bare copper covered steel; 0.064" OD (nominal); foamed polyethylene dielectric.
2. Four Layer Shield:
 - a. Inner shield: aluminum-polypropylene-aluminum laminated tape with overlap bonded to dielectric.
 - b. Second shield: 60% 34 AWG bare aluminum braid wire.
 - c. Third shield: non-bonded aluminum foil tape.
 - d. Outer shield: 40% 34 AWG bare aluminum braid wire.

B. Electrical Performance Characteristics:

1. Impedance: 75 ohms.
2. Velocity of propagation: \approx 82%.
3. Maximum attenuation (per 100 feet) for non-plenum rated cable:
 - a. at 55-MHz: 0.97 dB
 - b. at 450-MHz: 2.65 dB
 - c. at 750-MHz: 3.50 dB
 - d. at 1000-MHz: 4.23 dB
4. Maximum attenuation (per 100 feet) for plenum-rated cable:
 - a. at 50-MHz: 1.20 dB
 - b. at 400-MHz: 3.50 dB
 - c. at 700-MHz: 4.60 dB
 - d. at 1000-MHz: 5.60 dB

1. Belden 1617A (non-plenum cable)

2.5 RG-6 BROADBAND RF COAXIAL CABLE

A. Basic Construction:

1. Center conductor: 18 AWG bare copper covered steel; 0.040" OD (nominal); foamed polyethylene dielectric.
2. Four Layer Shield:
 - a. Inner shield: aluminum-polypropylene-aluminum laminated tape with overlap bonded to dielectric.
 - b. Second shield: 60% 34 AWG bare aluminum braid wire.

- c. Third shield: non-bonded aluminum foil tape.

B. Electrical Performance Characteristics:

1. Maximum attenuation (per 100 feet) for non-plenum rated cable:

- a. at 55-MHz: 1.60 dB
- b. at 450-MHz: 4.26 dB
- c. at 750-MHz: 5.59 dB
- d. at 1000-MHz: 6.54 dB

2. Maximum attenuation (per 100 feet) for plenum-rated cable:

- a. at 50-MHz: 1.60 dB
 - b. at 400-MHz: 4.60 dB
 - c. at 700-MHz: 6.60 dB
 - d. at 1000-MHz: 8.20 dB
- Acceptable Manufacturers:

- 1. Belden 1189A series
- 2. CommScope
- 3. West Penn
- 4. Times Fiber

2.6 COPPER WORK AREA CORDS

A. RJ-45:

- 1. Provide the same quantity of Category 6 Category 6A copper work area cords as copper patch panel cords specified in Section 27 1100. Copper work area cords shall be equipped with an 8-pin modular RJ-45 connector on each end.
- 2. Work area cords shall be 10' in length.
- 3. Manufacturer of copper patch cable shall be the same as the manufacturer of the horizontal copper cable.

B. RG-6 Broadband RF Coaxial with F-Connectors:

- 1. Provide one (1) coaxial work area cable for each CATV information outlet location installed.
- 2. Coaxial work area cables shall consist of quad-shielded RG-6 broadband RF coaxial cable meeting electrical performance characteristics specified earlier in this section, and be equipped with compression-style F-connectors on each end.
- 3. Work area cords shall be 7 feet in length.

PART 3 - EXECUTION

3.1 CABLE INSTALLATION REQUIREMENTS

A. Horizontal Cabling:

1. The maximum horizontal cable drop length for Data UTP shall not exceed 295 feet (90 meters) in order to meet data communications performance specifications. This length is measured from the termination panel in the wiring closet to the outlet and must include any slack required for the installation and termination. The Contractor is responsible for installing horizontal cabling in a fashion so as to avoid unnecessarily long runs. Any area that cannot be reached within the above constraints should be identified and reported to the Architect/Engineer prior to installation. Changes to the contract documents shall be approved by the Architect/Engineer.
 2. All cable shall be free of tension at both ends. In cases where the cable must bear some stress, Kellum grips may be used to spread the strain over a longer length of cable.
 3. Manufacturer's minimum bend radius specifications shall be observed in all instances.
 4. Horizontal cabling installed as open cabling shall be supported at a maximum of 5' between supports. Refer to the specifications for required cable supports.
 5. Horizontal cabling installed as open cable or in cable tray shall be bundled at not less than 10' intervals with hook-and-loop tie wraps. The use of plastic cable ties is strictly prohibited.
 6. The maximum conduit fill for horizontal cabling shall not exceed 40% regardless of conduit length.
 7. Cable sheaths shall be protected from damage from sharp edges. Where a cable passes over a sharp edge, a bushing or grommet shall be used to protect the cable.
- B. A coil of 3 feet in each cable shall be placed in the ceiling at the last support (e.g., J-hook, bridle ring, etc.) before the cables enter a fishable wall, conduit, surface raceway or box. At any location where cables are installed into movable partition walls or modular furniture via a service pole, approximately 15-feet of slack shall be left in each horizontal cable under 250 feet in length to allow for change in the office layout without re-cabling. These "service loops" shall be secured at the last cable support before the cable leaves the ceiling and shall be coiled from 100% to 200% of the cable recommended minimum bend radius.
1. Category 6A cables shall not be mixed with any other category cable in any bundle. Bundles of Category 6A cable shall maintain a 0.5" separation from bundles of cables containing different categories (e.g., Cat 6, Cat 5E).
 2. To reduce or eliminate EMI, the following minimum separation distances from 480V power lines shall be adhered to:
 - a. Twelve (12) inches from power lines of less than 5-kVa.
 - b. Eighteen (18) inches from high-voltage lighting (including fluorescent).
 - c. Thirty-nine (39) inches from power lines of 5-kVa or greater.
 - d. Thirty-nine (39) inches from transformers and motors.
 3. Information outlets shown on floor plans with the subscript "W" are intended to be used for wall mounted telephones. Back boxes for wall mounted telephones shall not be located within 12" vertically, or horizontally, from any light switches, power receptacles, nurse call devices, thermostats, or any other architectural element that would otherwise prevent the installation of a wall mounted telephone on the mating lugs.
- C. Horizontal Cabling in Modular Furniture:

1. This Contractor shall be responsible for providing and installing cable completely to the information outlet in the furniture. This Contractor's responsibility does not end at the furniture feed point.
2. Where furniture panels are installed to include contact with a wall, cabling shall be fed to the furniture panels via conduit.
3. Where modular furniture is installed without wall contact, the Contractor shall install cabling through floor fittings as shown on the drawings.
4. Cabling shall be protected in the transition from the floor or wall fittings to the modular furniture via a length of flexible plastic conduit or other approved protective means. Conduit fittings shall be compatible with the Floor and Wall Fittings proposed. There shall be no exposed cable in the transition to the modular furniture. Fill ratio (cable area vs. conduit area) in each feed shall not exceed 40%.
5. For purposes of bidding, it is to be assumed that the cable pathway shall be limited to the bottom panel of the modular furniture only. Communications cables would be run through these channels to the jack location.
6. For purposes of bidding, it is to be assumed that it will be the responsibility of the Contractor to punch and reinstall the bottom molding panels on the modular furniture as required to accommodate the communications cabling and information outlets. The panels shall be marked prior to installation by the Owner to identify the desired location of the information outlets.
7. The information outlet shall be secured to the panel via mounting tabs, pop-rivets, screws or other approved method. Use of adhesive tape is not acceptable. The method of securing the information outlet to the panel shall not result in sharp protrusions (e.g., sheet metal screw tip) into the channel behind the panel.

3.2 CABLE TERMINATION REQUIREMENTS

A. Cable Terminations - Shielded (T1):

1. Shielded cabling shall be terminated on 110-type termination blocks. The blocks shall be wall-mounted at all locations.
2. Blocks shall be sized to provide for a minimum 20% growth in capacity relative to the initial installation.
3. Consistency shall be maintained throughout the installation relative to conductor sequence on the blocks. Building ground and cable shield drain wire shall be terminated immediately to the left of each two data pairs on the cross-connect fields.
4. Designation labels shall be color-coded YELLOW to identify the cabling as a Network Connection. Pairs shall be identified on the labels numerically. Ground and shield shall be identified for each pair.

B. Cable Terminations - RG-6 and RG-11 Coax:

1. Directional coupler / taps shall be sized to accommodate an additional 20% growth in the number of cables terminated at any given location. Unused directional coupler / tap ports shall be terminated with a 75-Ohm F-type terminator.
2. All cables shall be terminated in the specified connector type and mated directly to wall-mounted directional coupler / taps. Coaxial cables shall be dressed neatly at the rear of the panel and secured to cable management brackets per manufacturer guidelines.

3. When preparing the RG-6 and RG-11 coaxial cable for termination, manufacturer's installation procedures shall be adhered to. Special care shall be taken to ensure the proper center conductor length as specified by the manufacturer.
4. All coaxial cable connectors shall be mated to the cable using only the appropriate purpose-designed tools recommended by the manufacturer for that purpose.

END OF SECTION

SECTION 27 1710 - TESTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section describes the testing requirements relating to the structured cabling system and its termination components and related subsystems.

1.2 RELATED WORK

- A. Section 27 0500 - Basic Communications Systems Requirements

1.3 QUALITY ASSURANCE

- A. Refer to Section 27 0500 for relevant standards.

1.4 SUBMITTALS

- A. Under the provisions of Section 27 0500 and Division 1, prior to the start of work, the Contractor shall submit:
 - 1. Complete information on testing procedure as described herein.
 - 2. Test plan summary for each cable type to be tested including equipment to be used, setup, test frequencies or wavelengths, results format, etc.

PART 2 - PRODUCTS

2.1 TESTING COPPER

- A. General Requirements:
 - 1. Perform acceptance tests as indicated below for each sub-system (e.g., backbone, horizontal, etc.) as it is completed.
 - 2. Supply all equipment and personnel necessary to conduct the acceptance tests. The method of testing shall be approved by the Architect/Engineer.
 - 3. Visually inspect all cabling and termination points to ensure that they are complete and conform to the wiring pattern defined herein. Provide the Architect/Engineer with a written certification that this inspection has been made.
 - 4. Conduct acceptance testing according to a schedule coordinated with the Owner/Architect/Engineer. Representatives of the Owner may be in attendance to witness the test procedures. Provide a minimum of one (1) week's advance notice to the Architect/Engineer to allow for such participation. The notification shall include a written description of the proposed conduct of the tests, including copies of blank test result sheets to be used.

5. Tests related to connected equipment of others shall only be done with the permission and presence of the Contractor involved. The Contractor shall ascertain that testing only is required to prove the wiring connections are correct.
6. Provide test results and describe the conduct of the tests including the date of the tests, the equipment used, and the procedures followed. At the request of the Architect/Engineer, provide copies of the original test results in their native format.
7. All cabling shall be 100% fault-free unless noted otherwise. If any cable is found to be outside the specification defined herein, that cable and the associated termination(s) shall be replaced at the expense of the Contractor. The applicable tests shall then be repeated.
8. Should it be found by the Architect/Engineer that the materials or any portion thereof furnished and installed under this Contract fail to comply with the specifications and drawings with respect or regard to the quality, amount, or value of materials, appliances, or labor used in the work, it shall be rejected and replaced by the Contractor and all work disturbed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.

a. CAT 6 Cable:

- 1) Testing shall be from the modular jack at the information outlet to the modular patch panel in the communication equipment room.
- 2) Horizontal cable shall be free of shorts within the pairs, and be verified for continuity, pair validity and polarity, and conductor position on the modular jack (e.g., wire map). Any defective, split, or mis-positioned pairs must be identified and corrected.
- 3) CAT 6 horizontal cable shall be tested to 250 MHz as defined by TIA/EIA-568-C.2. Measurements shall be of the "Channel Link", including patch cords, cabling and modular jacks at the information outlet and modular patch panel. Parameters to be tested must include:
 - a) Wire Map
 - b) Length
 - c) NEXT Loss (Pair-to-Pair)
 - d) NEXT (Power Sum)
 - e) ELFEXT (Pair-to-Pair)
 - f) ELFEXT (Power Sum)
 - g) Return Loss
 - h) Attenuation
 - i) Propagation Delay
 - j) Delay Skew
- 4) The maximum length of horizontal cable shall not exceed 295 feet, which allows 33 feet for technology equipment and modular patch cords.

- 5) To establish testing baselines, cable samples of known length and of the cable type and lot installed shall be tested. The cable may be terminated with an eight-position CAT 6 modular connector (8-pin) to facilitate testing. Nominal Velocity of Propagation (NVP) and nominal attenuation values shall be calculated based on this test and be utilized during the testing of the installed cable plant. This requirement can be waived if NVP and nominal attenuation data is available from the cable manufacturer for the exact cable type under test.
- 6) CAT 6 horizontal cable testing shall be performed using a test instrument designed for testing to 250 MHz or higher. Test records shall verify, "PASS" on each cable and display the specified parameters, comparing test values with standards based "templates" integral to the unit. Test records that report a PASS*, FAIL*, or FAIL result for any of the parameters will not be accepted.
- 7) In the event results of the tests are not satisfactory, the Contractor shall make adjustments, replacements, and changes as necessary and shall then repeat the test or tests that disclosed faulty or defective material, equipment, or installation methods, and shall make additional tests as the Architect/Engineer deems necessary at no additional expense to the project or user agency.

b. CAT 6A Cable:

- 1) Testing shall be from the modular jack at the information outlet to the modular patch panel in the communication equipment room.
- 2) Horizontal cable shall be free of shorts within the pairs and be verified for continuity, pair validity and polarity, and conductor position on the modular jack (e.g., wire map). Any defective, split, or mis-positioned pairs must be identified and corrected.
- 3) CAT 6A horizontal cable shall be tested to 500 MHz as defined by TIA/EIA-568-C.2. Measurements shall be of the "Channel Link", including patch cords, cabling and modular jacks at the information outlet and modular patch panel. Parameters to be tested must include:
 - a) Wire Map
 - b) Length
 - c) NEXT Loss (Pair-to-Pair)
 - d) NEXT (Power Sum)
 - e) ELFEXT (Pair-to-Pair)
 - f) ELFEXT (Power Sum)
 - g) Return Loss
 - h) Attenuation
 - i) Propagation Delay
 - j) Delay Skew
- 4) The maximum length of horizontal cable shall not exceed 295 feet, which allows 33 feet for technology equipment and modular patch cords.

- 5) To establish testing baselines, cable samples of known length and of the cable type and lot installed shall be tested. The cable may be terminated with an eight-position CAT 6A modular connector (8-pin) to facilitate testing. Nominal Velocity of Propagation (NVP) and nominal attenuation values shall be calculated based on this test and be used during the testing of the installed cable plant. This requirement can be waived if NVP and nominal attenuation data is available from the cable manufacturer for the exact cable type under test.
- 6) CAT 6A horizontal cable testing shall be performed using a test instrument designed for testing to 500 MHz or higher. Test records shall verify "PASS" on each cable and display the specified parameters, comparing test values with standards based "templates" integral to the unit. Test records that report a PASS*, FAIL*, or FAIL result for any of the parameters will not be accepted.
- 7) In the event results of the tests are not satisfactory, the Contractor shall make adjustments, replacements, and changes as necessary and shall then repeat the test or tests that disclosed faulty or defective material, equipment, or installation methods, and shall make additional tests as the Architect/Engineer deems necessary at no additional expense to the project or user agency.

2.2 TESTING FIBER

A. General Requirements:

1. Perform acceptance tests as indicated below for each optical fiber sub-system (e.g., backbone, horizontal, etc.) as it is completed.
2. Supply all equipment and personnel necessary to conduct the acceptance tests. The method of testing shall be approved by the Architect/Engineer.
3. Visually inspect all optical fiber cabling and termination points to ensure that they are complete and conform to the standards defined herein. Provide the Architect/Engineer with a written certification that this inspection has been made.
4. Conduct acceptance testing according to a schedule coordinated with the Owner/Architect/Engineer. Representatives of the Owner may be in attendance to witness the test procedures. Provide a minimum of one (1) week's advance notice to the Architect/Engineer to allow for such participation. The notification shall include a written description of the proposed conduct of the tests, including copies of blank test result sheets to be used.
5. Tests related to connected equipment of others shall only be done with the permission and presence of the Contractor involved. The Contractor shall ascertain that testing only is required to prove that the optical fiber connections are correct.
6. Provide test results and describe the conduct of the tests including the date of the tests, the equipment used and the procedures followed. At the request of the Architect/Engineer, provide copies of the original test results.
7. All optical fiber cabling shall be 100% fault-free unless noted otherwise. If any optical fiber cable is found to be outside the specification defined herein, that optical fiber cable and the associated connector(s) shall be replaced at the expense of the Contractor. The applicable tests shall then be repeated.

8. Should it be found by the Architect/Engineer that the materials or any portion thereof furnished and installed under this Contract fail to comply with the specifications and drawings with respect or regard to the quality, amount, or value of materials, appliances, or labor used in the work, it shall be rejected and replaced by the Contractor and all work disturbed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.
 9. The optical fibers utilized in the installed cable shall be traceable to the manufacturer. Upon request by the Owner, provide cable manufacturer's test report for each reel of cable provided. These test reports shall include manufacturer's on-reel attenuation test results at 850-nm and 1300-nm for each optical fiber of each reel prior to shipment from the manufacturer.
 - a. On-the-reel bandwidth performance as tested at the factory. Factory data shall be provided upon request.
 - b. The testing noted for optical fiber cabling utilizes an Optical Time Domain Reflectometer (OTDR). However, the Contractor may submit to the Architect/Engineer for pre-approval of alternate fiber optic testing equipment.
- B. Tests Prior to Installation: The Contractor, at their discretion and at no cost to the Owner, may perform an attenuation test with an OTDR at 850-nm or 1300-nm on each optical fiber of each cable reel prior to installation. Supply this test data to the Architect/Engineer prior to installation.
- C. Tests After Installation: Upon completion of cable installation and termination, the optical fiber cabling shall be tested to include:
1. Optical Attenuation ("Insertion Loss" Method):
 - a. Optical Attenuation shall be measured on all terminated optical fibers in one direction of transmission using the "Insertion Loss" method measurement in accordance with the TIA/EIA 526-14, Method B, and be inclusive of the optical connectors and couplings installed at the system endpoints. Access jumpers shall be used at both the transmit and receive ends to ensure that an accurate measurement of connector losses is made. Multimode optical fibers shall be tested at 850 ± 30 nm. Singlemode optical fibers (if applicable) shall be tested at 1300 ± 20 nm.
 - b. Attenuation of optical fibers shall not exceed the values calculated as follows:
 - 1) Attenuation (max.) = $2 * C + L * F + S$ dB.
 - 2) Where C is the maximum allowable Connector Loss (in dB), L is the length of the run (in kilometers), and F is the maximum allowable optical fiber loss (in dB/km). S is the total splice loss (# of splices * maximum attenuation per splice).
 2. Verification of Link Integrity (OTDR):

- a. All optical fibers shall be documented in one direction of transmission using an Optical Time Domain Reflectometer (OTDR). Multimode optical fibers shall be tested at 850-nm and 1300-nm (nominal). Singlemode optical fibers (if applicable) shall be tested at 1310-nm and 1550-nm (nominal). The OTDR(s) shall incorporate high-resolution optics optimized for viewing of short cable sections. Access jumpers of adequate length to allow viewing of the entire length of the cable, including the connectors at the launch and receive end, shall be used. Access jumpers used for testing shall match the type and core diameter of the fiber optic strand under test.
- b. Set OTDR's test variables to the manufacturer's published backscatter coefficient and velocity of propagation figure for the specific strand of fiber under test. OTDR's range should be set to approximately 1.5 times the length of the strand under test, pulse width should be optimized for the length of the fiber optic strand under test, and number of averages should be adjusted to approximately 120 seconds per wavelength.
- c. OTDR traces revealing a point discontinuity greater than 0.2 dB in a multimode optical fiber or 0.1 dB in a singlemode optical fiber (if applicable) at any of the tested wavelengths or any discontinuity showing a reflection at that point shall be a valid basis for rejection of that optical fiber by the Owner. The installation of that optical fiber cable shall be reviewed in an effort to remove any external stress that may be causing the fault. If such efforts do not remove the fault, that optical fiber cable and the associated terminations shall be replaced at the expense of the Contractor.

2.3 TESTING COAX

- A. A Time Domain Reflectometer (TDR) shall be used to verify cable length and to test for cable faults and breaks. A step-function high resolution Time Domain Reflectometer shall be employed for this test. The results shall be automatically plotted on an X-Y plotter with a Y axis voltage reflection coefficient resolution of .001 per division. The X axis will resolve down to 1" of cable. The TDR will sweep the cable at a rate no greater than 50' per second, or such lower rate as necessary to resolve cable faults to the 1" and .001 VRC level.
- B. The cable shall be terminated with its characteristic impedance, and an appropriate impedance matching pad shall be used to match the analyzer to the cable where necessary. Cable shall be rejected if any single fault is observed of amplitude greater than .003 voltage reflection coefficient. Characteristic impedance shall also be measured at 5% of nominal value.

2.4 DOCUMENTATION/AS-BUILTS/RECORDS

- A. General:
 1. Upon completion of the installation, submit as-builts per the requirements of Section 27 0500 and Division 1. Documentation shall include the items detailed in the subsections below.
 2. All documentation, including hard copy and electronic forms, shall become the property of the Owner.
 3. The Architect/Engineer may request that a 10% random field retest be conducted on the cable system at no additional cost to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the Contractor, additional testing can be requested to the extent determined necessary by the Architect/Engineer, including a 100% retest. This retest shall be at no additional cost to the Owner.

B. Copper Media Test Data:

1. Test results shall include a record of test frequencies, cable type, conductor pair and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).
2. Printouts generated for each cable by the wire test instrument shall be submitted as part of the documentation package. The Contractor shall furnish this information in electronic form (USB thumb drive). The thumb drive shall contain the electronic equivalent of the test results as defined by the bid specification and be in the tester's native format as well as summaries of each test in pdf format. Provide a licensed copy of the software required to view and print the data that is provided in a proprietary format. Furnish one (1) copy of the data and display (if applicable) software.

C. Optical Fiber Media Test Data:

1. Test results shall include a record of test wavelengths, cable type, fiber and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).
2. OTDR traces of individual optical fiber "signatures" obtained as specified above shall be provided to the Architect/Engineer in electronic form for review. Trace files shall be so named as to identify each individual optical fiber by location in the cable system and optical fiber number or color. Where traces are provided in electronic form, provide along with the above documentation, one (1) licensed copy of software that will allow for the display of OTDR traces provided. The software shall run on a Microsoft Windows-based personal computer.

D. Record Drawings:

1. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided.

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 27 1720 - STRUCTURED CABLING SYSTEM WARRANTY

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section describes support and warranty requirements relating to the structured cabling system and related subsystems.

1.2 RELATED WORK

- A. Section 27 0500 - Basic Technology Systems Requirements.
- B. Section 27 1100 - Communication Equipment Room (CER).
- C. Section 27 1300 - Backbone Cabling Requirements.
- D. Section 27 1500 Horizontal Cabling Requirements.

1.3 SUBMITTALS

- A. Under the provisions of Section 27 0500 and Division 1, prior to close of the project the Contractor shall submit:
 - 1. A numbered certificate from the manufacturing company registering the installation.

PART 2 - PRODUCTS

2.1 WARRANTY

- A. A twenty (20) year Product Installation Warranty and System Assurance Warranty shall be provided for the structured cabling system as described in the contract documents.
- B. The Product Installation Warranty shall cover the replacement or repair of the defective product(s) and labor for the replacement or repair of such defective product(s).
- C. The system assurance warranty shall cover the failure of the wiring system to support the application it was designed to support, as well as additional applications introduced in the future by recognized standards or user forums that use the TIA/EIA 568A component and link/channel specifications for cabling.
- D. Upon successful completion of the installation and subsequent inspection, the Owner shall be provided with a numbered certificate from the manufacturing company registering the installation.

PART 3 - EXECUTION

3.1 WARRANTY REQUIREMENTS

- A. This Contractor shall be responsible for providing, installing and testing a structured cabling system that will meet the manufacturer's warranty requirements.

END OF SECTION

SECTION 27 4100 - PROFESSIONAL AUDIO/VIDEO SYSTEM

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 0533 - Conduit
- B. Section 26 0513 - Wire and Cable
- C. Section 27 0500 - Basic Communications Requirements
- D. Section 27 0526 - Communications Bonding
- E. Section 27 0503 - Through Penetration Firestopping
- F. Section 27 1100 - Communication Equipment Rooms
- G. Section 27 0528 - Interior Communications Pathway
- H. Section 27 1500 - Horizontal Cabling Requirements
- I. Section 27 4200 - Electronic Digital Signage Systems

1.2 QUALITY ASSURANCE

- A. Manufacturer: The manufacturer of equipment shall have a complete service organization for all products in the manufacturer's line.
- B. Integrator/Dealer: The Contractor shall be a factory-authorized and certified integrator/dealer specializing in each selected manufacturer's products, with demonstrated prior experience with the selected manufacturer's system installation and programming.
- C. The following qualifications have been endorsed by the AudioVisual and Integrated Experience Association (AVIXA), which is formerly known as InfoComm International.
 - 1. The Contractor shall have obtain the services of a Certified Technology Specialist with a specialized Installation endorsement (CTS-I) and or a Certified Technology Specialist with a specialized Design endorsement (CTS-D) on staff and supervising the project. This service shall not be subcontracted. In addition to supervising the project, the CTS-I shall perform the following tasks on the project:
 - a. Review submittals and provide a letter stating the submittals are in compliance with the contract documents.
 - b. Provide written and dated confirmation of an observation of the contractor's installation activities no less than every 2 weeks month during the construction period.

- c. Provide a final written and dated confirmation of a final construction review prior to testing.
 - d. Review final testing and calibration of the systems and provide a letter with the documented results or transmittal of the results stating the test results and calibration compliance with the contract documents.
- D. A certification of CCENT or CCNA from CISCO. CCNP certification satisfies either of these requirements.
- E. The Contractor shall have in-house or retain the services of a Microsoft Certified Systems Engineer (MCSE) or equivalent technician for the purposes of server deployment, software configuration, and system integration for those systems that reside in a Microsoft environment.
- F. This project uses a video over IP AV solution and will require that the Contractor be proficient in distribution of video over an IP network. Aurora Multimedia is the basis of design. The Contractor is required to have the following certification requirements to support the system:
 - 1. Software Defined Video over Ethernet (SDVoE) Design Certification.
- G. The Contractor(s) shall provide a resume of prior experience in similar types and scales of projects, and other projects that may have been completed with the client. The resume shall include the project name, square footage, budget, system descriptions, and references with email addresses and phone numbers.
- H. Control System Dealer: The media control system shall be provided, terminated, installed, and programmed by a factory-authorized and certified dealer and integrator in good standing with the manufacturer. The dealer shall have direct purchasing and support authority. These services shall not be subcontracted.
- I. Control System Programmer: The media control system shall be programmed by a factory-trained and certified programmer.
 - 1. Should the installer of the system not employ a factory-trained and certified programmer, a representative from the equipment manufacturer or certified independent programmer shall be retained for programming services. The Contractor shall be responsible for payment of his/her services until the job is complete and signed off.
 - 2. The Contractor shall have all certifications required by the manufacturer(s) for the installed system components on staff for the appropriate duties and responsibilities required by the manufacturer.
 - a. The control system programmer shall have all refresher courses completed for the latest features of the control platform prior to bidding the project to ensure that the Contractor is up to date with the latest software features.
 - b. The control system programmer shall have achieved the highest programmer level obtainable by the installed control manufacturer (e.g., master programmer).
 - 3. The Contractor shall be fluent in the control systems preferred language (e.g., Python, C#, Java, JavaScript, SQL, PHP, etc.) required to complete the programming requirements of the AV system.

- a. Other languages may be required to integrate with other systems, such as the HVAC and lighting system. The Contractor shall coordinate the programming services with the on-site contractor for the integrated system. The Contractor shall hire the services of a certified contractor to program these other systems as required by the manufacturer of these other systems.

- J. Audio System Programmer: All digital sound processing equipment (DSP) used on the project shall be setup, programmed and calibrated by a factory-trained and certified technician. The audio system programmer shall have the following complementary certifications:
 - 1. Associated manufacturer certifications
 - 2. Dante Level III

- K. Video System Programmer: All video distribution and processing used on the project shall be setup, programmed and calibrated by a factory-trained and certified technician.

- L. The Contractor shall employ an ISF (Imaging Science Foundation) Level I certified video calibration specialist on staff to perform the calibration of the projectors and displays.

- M. The Contractor shall have acquired and maintained all certifications for a minimum of one (1) month prior to the posted bid date of this project.

- N. Servicing Contractor: The installer must be factory certified to provide service on the installed manufacturer's equipment and must have local service representatives within a 100 mile radius of the project site.

1.3 REFERENCES

- A. ADA - Americans with Disabilities Act
- B. ADAAG - Americans with Disability Accessibility Guidelines
- C. ANSI - American National Standards Institute
- D. AVIXA - Audiovisual and Integrated Experience Association (Formerly InfoComm)
- E. ANSI/InfoComm A102.01:2017 - Audio Coverage Uniformity
- F. ANSI/InfoComm 2M-2010 - Standard Guide for Audiovisual Systems Design and Coordination Processes
- G. ANSI/InfoComm F501.01:2015 - Cable Labeling for Audiovisual Systems
- H. ANSI/InfoComm 10:2013 - Audiovisual Systems Performance Verification
- I. ANSI/AVIXA V202.01:2016 - Display Image Size for 2D Content in Audiovisual Systems
- J. ANSI/InfoComm 4:2012 - Audio Visual Systems Energy Management
- K. ANSI/InfoComm 3M-2011 - Projected Image System Contrast Ratio

- L. IBC - International Building Code
 - M. IEC - International Electrotechnical Commission
 - N. NFPA 70 - National Electrical Code (NEC)
 - O. UL 813 - Commercial Audio Equipment
 - P. UL 1419 - Professional Video and Audio Equipment
 - Q. UL 1480 - Speakers for Fire Alarm, Emergency, and Commercial and Professional Use
 - R. UL 1492 - Audio/Video Products and Accessories
- 1.4 SUBMITTALS
- A. Submit shop drawings and product data under provisions of Section 27 0500.
 - B. General Requirements:
 - 1. Submittals will be submitted in multiple passes over the course of construction. Each pass will be a dedicated single submission for review as outlined in the general submittal requirements outlined in section 27 0500.
 - 2. Upon acceptance of an item in the submittal, the Contractor shall remove them from future resubmittals of the same submittal "pass".
 - 3. Should the Contractor not provide shop drawings in a timely fashion, not complete requirements, or extend the time of any resubmittals so as to jeopardize schedules, cause delay, or limit access for field work, the Contractor bears responsibility for impact and delay that may occur. This includes access or lift to overhead positions and associated protection of work already in place.
 - C. First Pass Submittals: To be submitted after the project is awarded but before equipment is submitted, purchased and installed.
 - 1. Contractor(s) resume of qualifications.
 - 2. All certifications shall be current and valid. Any certificate with expired dates will not be accepted.
 - 3. All applicable AudioVisual and Integrated Experience Association (AVIXA) certifications. Qualifications from InfoComm that have not expired will be accepted.
 - 4. All certifications outlined in the qualifications shall be included in this submittal. Refer to the qualifications section for additional information. Certifications include, but are not limited to:
 - a. All installed manufacturer certifications required by the manufacturer.
 - b. Control system authorized dealer certification.
 - c. Control system certified programmer certification(s).
 - d. Audio system DSP dealer certification.
 - e. Audio system DSP programmer certification.

5. If an alternate manufacturer(s) is submitted, the equivalent certifications to the basis of design manufacturer(s) shall be required and submitted.
 6. Audio and video calibration equipment certifications.
 7. Audio and video testing and calibration equipment and software procedures and manufacturer-specific equipment calibration certificates.
- D. Second Pass Submittals: To be submitted after all initial submittals have been approved but before equipment is purchased, installed, configured, and programmed. This can be submitted with the first pass submittal but will require to be submitted as a separate document.
1. Alternate System Drawings: If an approved alternate manufacturer is submitted, the Contractor shall provide project-specific system CAD drawings. These will be required to be submitted with the product data.
 - a. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (e.g., multiple identical controllers), the diagram may show one device and refer to the others as "typical" of the device shown.
 2. Product Data: Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:
 - a. Compliance with each requirement of these documents.
 - b. All component options and accessories specific to this project.
 - c. Electrical power consumption rating and voltage.
 - d. Wiring requirements.
 - e. Pre-terminated cable distances and requirements identified by each room where required.
 - f. Product manuals are not an acceptable format and will be rejected.
 3. Available wireless microphone frequencies within a 50 mile range based on the submitted system(s) and coordinated with the number of channels.
- E. Final Pass Submittals: To be submitted after all initial submittals have been approved but before the equipment is installed, configured and programmed. These should not be submitted until after the pre-installation meeting outlined in Part 3.
1. System Drawings: Project-specific system drawings shall be provided as follows:
 - a. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (e.g., multiple identical controllers), the diagram may show one device and refer to the others as "typical" of the device shown.
 - b. Submittals shall contain shop drawings indicating physical plan locations and placement of installed devices and accessories with associated scope or field conditions for review and coordination. Provide mounting details, suspensions, and rough-in notes with trade demarcations.

- 1) Identify any non-standard back boxes or mounting assembly required by product or specifications and elaborate contractor means and methods for mounting.
 - 2) Provide rack drawing(s) showing the mounting of equipment in each rack or cabinet on the project.
 - 3) All display mounts shall be coordinated with the Architect to verify the exact vertical and horizontal positioning of the display. Coordinate in-wall stud locations for installation of recessed display mounts to install in the exact location as coordinated with the architectural drawings.
 - 4) Projector mounts shall be coordinated with other utilities on the ceiling and wall to minimize any potential obstructions for the visual beam of the projector prior to installation of the projector mount.
 - 5) Projector mounts, projector screens, recessed ceiling speakers, in-ceiling microphones, and all other above ceiling devices shall be coordinated with other trades in the field (e.g., mechanical ductwork, lights, diffusers, etc.) to minimize changes that will impact the performance of the system design.
- c. Submit wiring and cable path requirements, including field wiring, path verification, signal separation, and outside diameter of cables for conduit sizing and verification that can be used for field installation and electrical coordination.
 - d. Reproduction of contract documents is not acceptable for submittals. Wire CAD type drawings and cable tag lists or schedules, or typical manufacturer's abbreviated single lines alone, are not complete.
2. The Contractor shall submit graphic or emulated representations of the control system touch panels for each unique space and layout prior to purchase, installation and programming for review and comment by the Architect/Engineer and Owner. These shall show and describe the intended programming/macro control features and functions of each button/icon for all pages.
 3. The Contractor shall submit graphic or emulated representations of the control system keypads for each unique space and layout prior to purchase, installation and programming for review and comment by the Architect/Engineer and Owner. These shall show and describe the intended programming/macro control features and functions of each button/knob.
 4. The Contractor shall submit the actual DSP audio processor files or single line audio path file diagram prior to installation for review and comment by the Architect/Engineer. Provide preliminary settings with processor blocks identified and note resources allocated.
 5. The Contractor shall submit the number of IP addresses, VLANS, and subnetworks that will be required from the Owner's Information Systems Department.
- F. Coordination Drawings:
1. Include all ceiling-mounted devices in composite electronic coordination files. Refer to Section 27 0500 for coordination drawing requirements.
- 1.5 SYSTEM DESCRIPTION
- A. This specification section describes the furnishing, installation, commissioning and programming of audio/video components and systems.

- B. Performance Statement: This specification section and the accompanying Contract Documents are performance based, describing the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed, every equipment connection that must be made and every feature and function that must be programmed and configured. Based on the equipment constraints described and the performance required of the system, as presented in these documents, the Vendor and the Contractor are solely responsible for determining all wiring, programming and miscellaneous equipment required for a complete and operational system.
- C. This document describes the major components of the system. All additional hardware, subassemblies, supporting equipment and other miscellaneous equipment required for proper system installation and operation shall be provided by the Contractor.
- D. This document describes the major programming features and functions of the system. All additional programming, configuration and integration required for proper system installation and operation shall be provided by the Contractor.
- E. When a specific manufacturer is not provided in this document for minor pieces of equipment, the Contractor shall provide only those materials considered to be of the same industry commercial and professional quality level as the major equipment manufacturers.
- F. General System Description:
 - 1. The purpose of this section is to define the overall AV system requirements for each space identified on the project drawings. This is to represent the end-user needs, applications, tasks and Functions and features for each space to assist with identifying programing requirements for each space.
- G. Room Type Requirements:
 - 1. Large Conference Room:
 - a. The large conference system shall provide support for videoconferences as well as presentations and meetings.
 - b. System Requirements:
 - 1) Provide in-room display of video sources including a Blu-ray player, QAM tuner, and video conferencing codec.
 - 2) Provide the capability for the display of temporary video sources connected through an auxiliary input panel in the floor box.
 - 3) Provide a ceiling-mounted dual technology occupancy sensor to enable the room control system.
 - 4) Provide connecting cabling from the floor box to a table-mounted connection box.
 - 5) Provide table-mounted boundary microphones for audio input to the videoconferencing codec.
 - 6) Provide a PTZ video camera for video input to the videoconferencing codec.
 - 7) Provide routing of video sources and accompanying audio via a matrix switcher.

- 8) Provide flat panel display mounted on the front wall of the room as the primary display device.
- 9) Provide ceiling loudspeakers and associated electronics to reproduce the mono or summed-stereo to mono audio signal.
- 10) Provide an equipment rack for the systems' permanently mounted equipment within a credenza closet.
- 11) Provide a control system with touch screen control panel.
- 12) The control system shall be controllable via LAN from HTML pages or the campus FUSION system.
- 13) The control system to provide control for:
 - a) System on/off
 - b) Audio and/or video source and destination selection
 - c) Audio level
 - d) Source on/off
 - e) Transport/channel control
 - f) Codec functions such as camera control, dialup, address book, etc.
- 14) Provide portable ALS system compliant with 2013 CBC 11B-219 and 11B-706, signage compliant with 2013 CBC 11B-216.10, and two (2) receivers, one of which shall be hearing aid compatible.

2. Medium Conference Room:

- a. The medium conference system shall provide support for videoconferences as well as presentations and meetings.
- b. Systems Description:
 - 1) Provide in-room display of video sources including a Blu-ray player, QAM tuner, and video conferencing codec.
 - 2) Provide the capability for the display of temporary video sources connected through an auxiliary input panel in the floor box.
 - 3) Provide a ceiling-mounted dual technology occupancy sensor to enable the room control system.
 - 4) Provide connecting cabling from the floor box to a table-mounted connection box.
 - 5) Provide table-mounted boundary microphones for audio input to the videoconferencing codec.
 - 6) Provide a PTZ video camera for video input to the videoconferencing codec.
 - 7) Provide routing of video sources and accompanying audio via a matrix switcher.
 - 8) Provide panel display mounted on the front wall of the room as the primary display device.
 - 9) Provide ceiling loudspeakers and associated electronics to reproduce the mono or summed-stereo to mono audio signal.
 - 10) Provide an equipment rack for the systems' permanently mounted equipment within a credenza closet.
 - 11) Provide a control system with touch screen control panel.

- 12) The control system shall be controllable via LAN from HTML pages or the campus FUSION system.
- 13) The control system to provide control for:
 - a) System on/off
 - b) Audio and/or video source and destination selection
 - c) Audio level
 - d) Source on/off
 - e) Transport/channel control
 - f) Codec functions such as camera control, dialup, address book, etc.

3. Huddle Space

- a. The huddle space shall provide support for meetings and videoconferencing via a soft codec.
- b. System Requirements:
 - 1) Provide capability for the display of temporary video sources connected through a wall plate mounted 6" above the work surface and below the display.
 - 2) Provide a ceiling-mounted dual technology occupancy sensor to enable the room control system.
 - 3) Provide a 4K LED flat panel display with built-in speakers mounted on the front wall of the room as the primary display device.
 - 4) Provide USB camera with built-in microphone and separate mount to enable videoconferencing.
 - 5) Provide a control system with keypad control panel touch screen control panel.
 - 6) The control system shall be controllable via LAN from HTML pages or the campus FUSION system.
 - 7) The control system to provide control for:
 - a) System on/off
 - b) Display input selection
 - c) Audio level
 - d) Channel control
- c. Architectural and Infrastructure Requirements:
 - 1) Provide appropriate backing for mounting the display to the wall. Coordinate with electrical backboxes.
- d. Electrical Requirements:
 - 1) At Display:
 - a) Provide one (1) 120VAC, 20A quad receptacle behind display. Refer to drawings for elevation.
 - b) Provide flat panel display recessed back box with integrated surge suppression and hardwired 120VAC, 20A connection.

- 2) At Table:
 - a) Provide one (1) 120VAC, 20A duplex receptacle 6" above table height and below flat panel display.
 - 3) Acoustical Requirements (Recommendations):
 - 4) Information Technology (IT) Requirements (Recommendations):
 - a) Provide WAN coverage.
 - b) Provide network drop behind display.
 - c) Provide network drop at keypad location.
 - 5) AV System Description:
 - a) A wall plate mounted below the display will allow one (1) HDMI source connection and one (1) USB connection. The HDMI cabling shall be routed from the wall plate to the display. The USB connection shall be routed to a USB camera mounted below the display. A user shall be able to connect their laptop to the HDMI and USB for a video conference using the display's speakers and the USB camera's microphone. Control shall be provided by a keypad with buttons for display on/off, input selection, volume up/down and CATV channel up/down.
4. Classroom
- a. The classroom shall provide support for class instruction, recording, and streaming class instruction.
 - b. System Requirements:
 - 1) Provide two (2) ceiling-mounted 7000 lumen 4K projectors as the primary display.
 - 2) Provide two (2) ceiling-mounted recessed electric screens.
 - 3) Provide a wireless AV device.
 - 4) Provide the capability for the display of temporary video sources connected through an auxiliary input panel in the floor box at the instructor's station.
 - 5) Provide lecture capture system capable of recording and streaming content.
 - 6) Provide a ceiling-mounted dual technology occupancy sensor to enable the room control system.
 - 7) Provide connecting cabling from the floor box to a surface-mounted connection box on the instructor's station.
 - 8) Provide one (1) gooseneck microphone for audio input at the instructor's station.
 - 9) Provide wireless lavalier microphone system.
 - 10) Provide a PTZ video camera for video input to the lecture capture system.
 - 11) Provide two (2) confidence monitors at the instructor's station. One shall display source content; the other shall display an output of the PTZ camera.
 - 12) Provide routing of video sources and accompanying audio via a matrix switcher.
 - 13) Provide ceiling loudspeakers and associated electronics to reproduce the mono or summed-stereo-to-mono audio signal.

- 14) Provide an equipment rack for the systems' permanently mounted equipment within the instructor's station.
 - 15) Provide a control system with touch screen control panel located at the instructor's station.
 - 16) The control system shall be controllable via LAN from HTML pages or the campus FUSION system.
 - 17) The control system to provide control for:
 - a) System on/off
 - b) Audio and/or video source and destination selection
 - c) Audio level
 - d) Source on/off
 - e) PTZ camera control
 - f) Lecture capture record start/stop
 - 18) Provide portable ALS system compliant with 2013 CBC 11B-219 and 11B-706, signage compliant with 2013 CBC 11B-216.10, and two (2) receivers, one of which shall be hearing aid compatible.
- c. Architectural and Infrastructure Requirements:
- 1) Provide appropriate backing for mounting the display to the wall. Coordinate with electrical backboxes.
- d. Electrical Requirements:
- 1) At Projectors:
 - a) Provide one (1) 120VAC, 20A duplex receptacle mounted in ceiling at each projector. Refer to drawings for location.
 - 2) At Projection Screens:
 - a) Provide one (1) 120VAC, 20A hard connection at each electric screen.
 - 3) At Instructor's Station:
 - a) Provide two (2) 120VAC, 20A circuits to floor box at instructor's station.
- e. Acoustical Requirements (Recommendations):
- f. Information Technology (IT) Requirements (Recommendations)
- 1) Provide WAN coverage.
 - 2) Provide network drop at each projector.
 - 3) Provide network drop at touch panel location.
 - 4) Provide two (2) network drops at instructor's station.
- g. AV System Description:

- 1) Instructor will control the system via the touch panel located at the instructor's station. The touch panel shall control switching of AV inputs to all displays. Ceiling mounted PTZ camera shall provide a view of the teaching wall for lecture capture. Ceiling speakers shall provide voice lift for the instructor and program audio from connected sources.

H. System Room Drawing Reference: AV SYSTEM

<u>ROOM DESCRIPTION/NAME</u>	<u>FUNCTIONAL DRAWING</u>
Large Conference Room	x/Txxx

1.6 LICENSING REQUIREMENTS

- A. All user licenses required for system operation shall be included in the Contractor's bid. User licenses shall include, but not be limited to, server and workstation software and any other licensing that is required by the manufacturer for operation of any system component.
 1. Licenses shall be provided on a one-to-one basis. One license shall be provided for each server, workstation, and device requiring a license. In the event the manufacturer requires the purchase of a block of licenses, the minimum standard licensing package to support all devices shall be provided.
 2. In addition to the licensing requirements listed above, provide licensing and configuration of remote central asset management, scheduling, and control software on up to Owner-provided workstations.

1.7 INTELLECTUAL PROPERTY OWNERSHIP

- A. All supporting documentation, programming, uncompiled source code, graphic files, DSP code and diagrams, written and electronic files, including all latest versions of the documentation and software necessary to edit and adapt the system(s), shall be provided to the Owner for all spaces and all systems. The integrator and/or programmer shall also maintain a current copy to be provided at the Owner's request.
 1. The Owner shall have the right to modify the intellectual property directly, or to have the intellectual property modified by any party of the Owner's choosing.

1.8 PROJECT RECORD DOCUMENTS

- A. Submit documents under the provisions of Section 27 0500.
- B. Provide all applicable certifications.
- C. Provide statement that system checkout test, as outlined in the shop drawing submittal, is complete and satisfactory.
- D. Provide schedules documenting all terminal block wiring, including cable numbers.
- E. Warranty: Submit written warranty and complete all Owner registration forms.

- F. Complete all operation and maintenance manuals as described below.
- G. The Contractor shall include all factory-provided test results for equipment installed on the project.
- H. The Contractor shall include all test results from system demonstration and performance testing specified in this document.
- I. Record Drawings shall minimally include:
 - 1. All revisions to, or deviations from the original drawings, as well as final dimensions, cable routes, connector panel drawings, cable numbering charts, and control system programming documentation. A complete as-installed equipment list, listed by room, and with manufacturers' names, model numbers, serial numbers, and quantities of each item.
 - 2. A complete and correct system schematic, showing detailed connections for all parts of the system, including wire numbers, terminal block numbers and layouts, and other designations and programming code.
 - 3. Complete equipment rack layouts showing locations of all rack-mounted equipment items.
 - 4. Additional information, diagrams or explanations as designated under respective equipment or systems specification section.
- J. Within each equipment room, the appropriate floor plan for which that equipment room serves shall be laminated and mounted for use by the Owner. Functional drawings shall be posted at each AV closet or included at every AV rack within a room.
- K. Upon completion and final acceptance of the project, the Contractor shall provide the Owner a copy of the programming code for any and all AV systems and devices programmed by the Contractor.
 - 1. For any subsequent modifications to the programming code, an updated copy of the code shall be provided to the Owner.

1.9 OPERATION AND MAINTENANCE DATA

- A. Submit documents under the provisions of Section 27 0500.
- B. Manuals: Final copies of the manuals shall be delivered after completing the installation. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of the Contractor responsible for the installation and maintenance of the system and the factory representatives for each item of equipment for each system. The manuals shall have a table of contents and labeled sections. The final copies delivered after completion of the installation shall include all modifications made during installation, checkout, and acceptance. Manuals shall be submitted in[both hard copy and] electronic format. The manuals shall consist of the following:
 - 1. Functional Design Manual: The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included.
 - 2. Hardware Manual: The manual shall describe all equipment furnished including:

- a. General description and specifications.
 - b. Installation and checkout procedures.
 - c. Equipment layout and electrical schematics to the component level.
 - d. System layout drawings and schematics.
 - e. Alignment and calibration procedures.
 - f. Manufacturers repair parts list indicating sources of supply.
3. Software Manual: The software manual shall describe the functions of all software and shall include all other information necessary to enable proper loading, testing, and operation. The manual shall include:
- a. Definition of terms and functions.
 - b. System use and application software.
 - c. Initializations, startup, and shutdown.
 - d. Reports generation.
 - e. Details on forms customization and field parameters.
4. Operator's Manual: The operator's manual shall fully explain all procedures and instructions for the operation of the system including:
- a. Computers and peripherals.
 - b. System startup and shutdown procedures.
 - c. Use of system, command, and applications software.
 - d. Recovery and restart procedures.
 - e. Use of report generator and generation of reports.
 - f. Data entry.
 - g. Operator commands.
 - h. Alarm messages and reprinting formats.
 - i. System permissions functions and requirements.
5. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.
- C. Video Calibration Data: Provide documentation of all calibrated settings for each projector and display.
- D. Audio Calibration Data: Provide documentation on all EQ settings, crossover points, limiter settings, gate settings and all other applicable settings.
- E. Intellectual Property Ownership: Provide all uncompiled source code and DSP programming for all systems and spaces as described in Part 3 of this specification section.
- 1.10 WARRANTY
- A. Unless otherwise noted, provide warranty for one (1) year after Date of Substantial Completion for all materials and labor.
 - B. Onsite Work During Warranty Period: This work shall be included in the Contractor's bid and performed during regular working hours, Monday through Friday.

1. Inspections: The Contractor shall perform two (2) minor inspections at even intervals (or more often if required by the manufacturer), and two (2) major inspections offset equally between the minor inspections.
 2. Minor Inspections: These inspections shall include:
 - a. Visual checks and operational tests of all equipment, field hardware, and electrical and mechanical controls.
 3. Major Inspections: These inspections shall include all work described under paragraph Minor Inspections and the following work:
 - a. Clean all equipment, including filters, interior and exterior surfaces.
 - b. Perform diagnostics on all equipment.
 - c. Check, test, and calibrate (if required) any sensors or other equipment that contain settings.
 - d. Check zoom and focus of all projectors.
 - e. Run all system software diagnostics and correct all diagnosed problems.
- C. Operation: Upon the performance of any scheduled adjustments or repairs, Contractor shall verify operation of the systems.
- D. Emergency Service: The Owner will initiate service calls when the systems are not functioning properly. Qualified personnel shall be available to provide service within the distance defined within this specification section. The Owner shall be furnished with telephone number(s) where service personnel can be reached 24/7/365. Service personnel shall be at site within 24 hours after receiving a request for service.
- E. Records and Logs: The Contractor shall keep records and logs of each task completed under warranty. The log shall contain all initial settings at substantial completion. Complete logs shall be kept and shall be available for review on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the systems.
- F. Work Requests: The Contractor shall separately record each service call request on a service request form. The form shall include the model and serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing what must be done, the amount and nature of the materials used, the time and date work started, and the time and date of completion. The Contractor shall deliver a record of the work performed within five (5) business days after work is accomplished.
- G. System Modifications: The Contractor shall make any recommendations for system modification in writing to the Owner. No system modifications shall be made without prior approval of the Owner. Any modifications made to the system shall be incorporated into the operations and maintenance manuals, and other documentation affected. To the fullest extent possible, the Owner shall be provided with electronic restorable versions of all configurations prior to the modifications being made.

- H. Software: The Contractor shall provide all software and firmware updates during the period of the warranty and verify operation of the system upon installation. These updates shall be accomplished in a timely manner, fully coordinated with system operators, shall include training for the new changes/features, and shall be incorporated into the operations and maintenance manuals, and software documentation.
- I. Refer to the individual product sections for further warranty requirements of individual system components.

1.11 ANNUAL SERVICE CONTRACT

- A. Provide annual cost for extended service and maintenance warranty after the first year for the audio/video systems according to the following terms:
 - 1. The term of the warranty shall begin on the system acceptance date and shall continue for one (1) year. The extended service and maintenance warranty may begin following this first year if accepted by the Owner. The term may be automatically renewed for successive one-year periods unless canceled by the Owner. The service and maintenance agreement shall include the following basic services to the Owner, including all necessary parts, labor and service equipment:
 - a. Repair or replace any equipment item that fails to perform as initially installed, as specified, or as determined per the manufacturer's performance criteria.
 - b. Perform semi-annual preventive maintenance on the equipment. This preventive maintenance shall include, but is not limited to, cleaning, realignment, bulb replacement, filter cleaning and replacement, inspection, re-calibration, and testing of devices. The Owner shall receive a written report of these inspections that identifies the device's status and, if required, a list of all necessary repairs or replacements.
 - c. Provide software and firmware maintenance on the system. Contractor shall install and configure any software and firmware updates that the manufacturer provides at no cost. Any additional software or firmware options, updates, or enhancements purchased by the Owner shall be installed. The Contractor shall not be responsible for the purchase of additional software packages or the maintenance of Owner data.
 - 2. The Contractor shall be compensated for any repairs or maintenance provided as a result of Owner abuse, misuse, intentional damage, accidental damage, or power fluctuations exceeding specified equipment tolerances.
 - 3. System defects or failures shall be corrected within four (4) hours on the same business day if the Owner makes a service request before 11:00 am, or before 12:00 noon the next business day if the Owner makes the request after 11:00 am. If requested by the Owner, the Contractor shall respond or remain at the site after normal business hours, and the Owner shall reimburse the Contractor for the incremental cost difference between premium labor rates and standard labor rates. This reimbursement applies to premium labor rates that do not exceed time-and-one-half rates after normal business hours and double-time rates for Sundays and holidays. The Contractor's services shall be performed in a good and workmanlike manner and remain free from defects for a period of one (1) year.
- B. Provide complete terms and conditions of warranty and service.

- C. The Owner will enter into a contract directly with the vendor. This specification is not a contract between the Owner and the vendor to perform these services.

1.12 EXTRA MATERIALS

- A. Furnish extra materials as described below.
- B. Extra stock shall match products installed and shall be packaged with protective covering for storage. Provide identification labels describing contents. Deliver extra materials to Owner.
 - 1. Projector bulbs for each type of projector installed.
 - a. If projector is equipped with one (1) bulb, provide a total of two (2) extra bulbs.
 - b. If projector is equipped with more than one (1) bulb, provide a total of two (2) extra bulbs for each bulb within the projector.
 - 2. Filters: Provide a total of two (2) filters for each device that uses filters. If the device is equipped with more than (1) filter, provide a total of two (2) filters for each filter.

PART 2 - PRODUCTS

2.1 SYSTEM COMPONENTS

- A. Refer to the project drawings for basis of design system components. Equivalent products shall meet or exceed all requirements defined on the project drawings. The following product information represents the minimum additional requirements for equivalent products:
- B. Audio/Video GUI Control Systems:
 - 1. Contractor shall furnish a programmable software-based audio/video control system. The system shall be field configurable and programmable by the factory and/or a factory-trained programmer.
 - 2. The control system shall be TCP/IP based allowing direct connection of the system processors to a 10/100BaseT compatible Ethernet network.
 - 3. The control system(s) shall connect to a centralized software-based management system for central control, monitoring and statistical information.
 - 4. Virtual touch panel and keypad control shall be provided for remote trouble shooting and control.
 - 5. Refer to project drawings for required central processors, touch panels, keypads and additional information.
- C. Microphone Systems:
 - 1. Wireless Microphones:
 - a. Wireless microphones shall not operate in the 614 to 806 MHz band (channels 38 to 69).
 - b. Features:

- 1) Dual antenna reception with true diversity reception.
- c. Microphone systems that are common (shared) by multiple spaces or when the receivers are in a remote area shall include a compatible wireless antenna distribution system by the same manufacturer as the wireless microphone system.

D. Audio Amplifiers:

1. Power Amplifier(s), 25, 70.7 and 100 Volt:

- a. Power: The following calculation shall be used to determine the minimum required output of the amplifier(s):

- 1) Calculate the total power tap value of each transformer with insertion loss using the following equation:
 - a) Tap wattage $\times 10^{(xdB/10)}$ where x = the rated insertion loss at 1,000Hz.
- 2) Calculate the total wattage loss based on cable distance, cable gauge and cable resistance.
- 3) Add together all the speaker taps' total power values that will be on a single channel of the amplifier. Multiply that total by [1.2] <Insert>, which will allow for a [20%] <Insert> future expansion. Multiply that number by 1.25 to ensure the amplifier never exceeds 75% of its total output. Utilize the final number to determine the minimum amplifier power requirements.

E. Assisted Listening Systems (ALS):

- 1. All spaces with amplified audible communications require an ALS. The Contractor shall refer to the ADA and ADAAG guidelines, as well as IBC Section 1108.2.7 for ALS rules, regulations and guidelines. Refer to the table below for the required number of receivers to be provided for each space (Source: IBC, Table 1108.2.7.1). Alternatively, if the building is managed by a single entity and all systems are fully compatible and interoperable, the total number of seats for all areas can be used in accordance with the table below.

Capacity of Seating in Assemble Areas	Minimum Required Number of Receivers	Minimum Number of Receivers to be Hearing-aid (T-coil) Compatible
50 or less	2	2

- 2. Receivers required to be hearing-aid compatible shall interface with telecoils in hearing aids through the provision of neckloops and shall be over-the-ear type headphones. Earbuds are not acceptable for this use.
- 3. Receivers shall include a 1/8" (3.2mm) standard mono output jack.
- 4. Refer to the Access Board Research "Large Area Assistive Listening Systems: Review and Recommendations" ALS report for additional recommendations.

F. Power Conditioning and Surge Protective Devices:

1. All equipment shall be plugged in through a power conditioning surge arrestor.
2. Provide a minimum of 50 dB noise attenuation.
3. Provide a minimum of 1,500 joules of surge protection.
4. UL 1449 “” Standard for Safety for Surge Protective Devices listed to 330 volt clamping voltage.
5. Provide automatic voltage regulation from 97 VAC to 137 VAC at a minimum to maintain a stable 120 VAC where specified.
6. Power sequencers shall be equipped with bi-directional RS-232 or Ethernet control for remote turn on and off.
7. Refer to the project drawings for additional information.

G. Uninterruptible Power Supplies (ups):

1. UPS shall be sized to accommodate the full startup VA load of all connected equipment for a minimum of fifteen (15) minutes. Adequate time shall be provided so all equipment can go through its normal shutdown sequence.
2. UPS shall be equipped with bi-directional RS-232 or Ethernet control for remote turn on/off control and status monitoring.
3. UPS shall provide automatic voltage regulation to maintain a stable 120VAC.
4. UPS shall provide power conditioning and surge protection to meet the UL 1449 “” Standard for Safety for Surge Protective Devices listing to 330 volt clamping voltage.
5. UPS shall be UL 1778 “” Uninterruptible Power Supply Equipment listed.

H. Digital Video Signal Equalizers and Regenerators:

1. For any cable run that exceeds the manufacturer-recommended distances or fails to transmit video or audio due to cable length, the Contractor shall provide and install a signal equalizer at the far end (sink) with the following minimum features:
 - a. HDMI/DVI equalizers shall be HDCP compliant and support actively buffered DDC transmission.
 - b. Display port equalizers shall be HDCP and DPCP compliant, support actively buffered DDC transmission, and be DP++ compatible.
 - c. Provide automatic equalization.
 - d. Pass all embedded audio and metadata.
 - e. Have an auxiliary power input when adequate power is not available on the cable.
 - f. Provide output reclocking and jitter reduction for multi-rate SDI signals.
2. For any cable run that that fails to transmit video or audio due to a weak source signal, the Contractor shall provide and install a signal regenerator at the near end (source) with the following minimum features:
 - a. HDMI/DVI regenerators shall be HDCP compliant and support actively buffered DDC.
 - b. Display port regenerators shall be HDCP and DPCP compliant, support DDC transmission, and be DP++ compatible.
 - c. Provide automatic output reclocking and jitter reduction.
 - d. Pass all embedded audio and metadata.
 - e. Have an auxiliary power input when adequate power is not available on the cable.

2.2 DIGITAL VIDEO CABLING

- A. All digital video cabling shall be pre-assembled and tested in a factory and not field terminated. The contractor shall field verify the cable distance and provide the proper cable type and length.
- B. High Definition Multi-Media Interface (HDMI) "High Speed" Cable:
 - 1. For any cable run that exceeds the manufacturer-recommended distances or fails to transmit video or audio due to cable length, the Contractor shall provide and install an HDCP-compliant signal equalizer at the far end (sink).
 - 2. For cable runs less than or equal to 25 feet:
 - a. Four (4) 28AWG solid bonded twisted pairs for clock and data, and seven (7) 28AWG solid conductors for control.
 - b. Two Layer Shield:
 - 1) Inner shield: non-bonded aluminum foil tape.
 - 2) Outer shield: 85% tinned copper braid shield.
 - c. Nominal attenuation of clock and data pairs (per 100 feet):
 - 1) at 100-MHz: 9.6 dB
 - 2) at 400-MHz: 19.3 dB
 - 3) at 825-MHz: 28.9 dB
 - 4) at 1200-MHz: 36.1 dB
 - d. Nominal capacitance between shielded pairs: 15.3 pF/ft nominal.
 - e. Nominal capacitance between control pairs: 16.5 pF/ft nominal.
 - f. Nominal return loss of shielded pairs: 15 dB, 1-1200 MHz.
 - g. Nominal shield DC resistance of individual shield: 24.4 ohms/1000 ft.
 - h. Nominal shield DC resistance of overall shield: 3.7 ohms/1000 ft.
 - i. The cable shall be HDMI 1.3a Category 1 certified to 25 feet, and HDMI 1.3a Category 2 certified to 15 feet.
 - j. Supports a maximum digital data rate of 10.2 Gbit/s.
 - k. Supports up to eight (8) channels of HD audio.
 - l. HDCP compliant.
 - m. Manufacturers:
 - 1) Belden
 - 2) Or pre-approved equal
 - 3. For cable runs greater than 25 feet:
 - a. Four (4) 24AWG solid bonded twisted pairs for clock and data, and seven (7) 24AWG solid conductors for control.
 - b. Two Layer Shield:
 - 1) Inner shield: non-bonded aluminum foil tape.
 - 2) Outer shield: 82% tinned copper braid shield.

- c. Nominal attenuation of clock and data pairs (per 100 feet):
 - 1) at 100-MHz: 6.0 dB
 - 2) at 400-MHz: 13.5 dB
 - 3) at 825-MHz: 19.8 dB
 - 4) at 1200-MHz: 24.1 dB
- d. Nominal capacitance between shielded pairs: 15.3 pF/ft nominal.
- e. Nominal capacitance between control pairs: 16.5 pF/ft nominal.
- f. Nominal return loss of shielded pairs: 15 dB, 1-1200 MHz.
- g. Nominal shield DC resistance of individual shield: 15.0 ohms/1000 ft.
- h. Nominal shield DC resistance of overall shield: 1.75 ohms/1000 ft.
- i. The cable shall be HDMI 1.3a Category 1 certified to 45 feet, and HDMI 1.3a Category 2 certified to 25 feet.
- j. Supports a maximum digital data rate of 10.2 Gbit/s.
- k. Supports up to eight (8) channels of HD audio.
- l. HDCP compliant.
- m. Manufacturers:
 - 1) Belden
 - 2) Or pre-approved equal

C. Display Port Cable:

- 1. For any cable run that exceeds the manufacturer-recommended distances, the Contractor shall provide and install an HDCP and DPCP compliant signal equalizer at the far end (sink).
- 2. Supports a maximum digital data rate of 8.64 Gbit/s.
- 3. Supports HDCP and DPCP.
- 4. Manufacturers:
 - a. Blue Jeans Cable
 - b. Or pre-approved equal

2.3 HORIZONTAL COPPER DATA AND FIBER CABLING AND CONNECTORS

- A. Refer to Section 27 1500 - Horizontal Cabling Requirements, for telecommunications cabling and connector requirements including fiber optics being utilized for A/V systems.
- B. Refer to Section 27 1710 - Testing, for telecommunications cabling testing requirements including fiber optics being utilized for A/V systems.
- C. All category-rated copper data cabling and fiber optic cabling shall be installed, terminated, tested and certified by the Division 27 Telecommunications contractor certified by the selected manufacturers for the copper and fiber optic cabling plant. The Contractor shall submit all cabling and certifications to the Architect/Engineer for approval in the shop drawings.
- D. The A/V contractor shall coordinate purchase, installation, testing and certification with the telecommunications contractor for all required category-rated copper data cabling and fiber optic cabling required for A/V system operation prior to bid.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Verify field dimensions and coordinate physical size of all equipment with the architectural requirements of the spaces into which they are to be installed. Allow space for adequate ventilation and circulation of air.
- C. Verify that required utilities are available, in proper location, and ready for use.
- D. Beginning of installation means installer accepts existing conditions.

3.2 PRE-INSTALLATION

- A. A pre-installation meeting shall be held after the project has been awarded but before any submittals or work has been conducted. The purpose of this meeting is to review the drawings and specifications to assist with the construction and installation process that will occur during construction. The meeting will include the Engineer, Architect, Owner's Representative, and all relevant installing contractors for this system. The meeting will be chaired by the project manager for the AV contract and will include the following topics:
- B. The Contractor shall be responsible for submitting all requested submittals and holding the pre-installation meeting prior to any purchasing, installation, programming, and construction coordination. Any delays or changes to the project as a result of meeting this requirement will be at the Contractor's expense.

3.3 INSTALLATION

- A. Comply with the manufacturer's instructions and recommendations for installation of all products.
- B. Provide all system wiring between all components as directed by the manufacturer or required for proper system operation.
- C. Mount all touch screen and keypad devices where shown on plans in accordance with Americans with Disabilities Act (ADA) requirements for both side reach and front reach.
- D. Cabling Requirements:
 - 1. Non-plenum rated cabling may be used instead of plenum when installed with-in conduit in plenum rated areas.
 - 2. All cabling shall be routed according to function. Cabling shall be grouped and bundled by groups, such as: microphone and line level audio, control, video and speaker. In no case shall cabling from different functional groups be intermixed. No cabling shall be routed parallel to 120 VAC or higher power circuits unless separated by a minimum of 6" and the 120 VAC or higher power is installed in conduit.
 - 3. When cabling is installed in conduit, a separate conduit shall be provided for each cabling functional type.

4. Cable bundles shall be loosely bundled to allow the visual following of individual cables within the bundle and to permit the easy removal and addition of cables as necessary.
 5. Horizontal cabling installed as open cable or in cable tray shall be bundled at not less than 10' intervals with hook-and-loop tie wraps. The use of plastic cable zip ties is strictly prohibited in any situation.
 6. Cabling shall not be spliced under any circumstances.
 7. Each cable shall be appropriately identified (as defined on the record documents) at each end's termination point using pressure sensitive label strips.
 8. Twisted Pair Cabling for All Applications:
 - a. The Contractor shall ensure that the twists in each cable pair are preserved to within 0.5 inch of the termination. The cable jacket shall be removed only to the extent required to make the termination.
 - b. The Contractor shall ensure that the cable shields are continuous throughout, terminated, and grounded according to the manufacturer's recommendations.
- E. Grounding Requirements:
1. Provide a minimum of #6 AWG conductor from the nearest electrical service ground bus or nearest telecommunications room ground bus bar to the A/V equipment racks and cabinets regardless of location. Size cable as required by the NEC.
 2. Cables containing shields shall not have the shields grounded at conduits, boxes, racks, etc. Ground the shield only at the equipment end.
 3. Audio cable shields for line-level signals shall be connected to the metal equipment chassis at both ends of the cable.
 4. Audio cables connected to transformers shall have the cable shield connected to the transformer shield and transformer case ground.
 5. The Contractor shall not connect cable shields together from differing cables.
 6. XLR cable shields shall be connected to chassis ground.
 7. Signal-grounded balanced shields are not acceptable and shall not be installed. All balanced shields shall be chassis grounded.
- F. Rack and Cabinet Requirements:
1. Ground equipment racks/cabinets as noted within this specification section and Section 27 0526 - Communications Grounding.
 2. Provide one (1) RU of space between adjacent pieces of equipment with top and/or bottom vents, above the topmost piece of equipment, and below the bottommost piece of equipment. Provide a vented cover panel covering each rack space.
 3. Terminate all speaker cabling on individual barrier strips for positive "+", negative "-", and shield. The shield barrier strip shall be grounded.
 4. Provide a power conditioning surge arrestor in the rack for distribution of AC power from the wall receptacles indicated on the plans. The quantity of plugs shall be adequate so that no equipment in the rack shall require plugging into an AC source outside the rack.
 5. Power sequencing shall be provided in the racks where shown on the drawings. All amplifiers located in the racks shall be sequenced "last on – first off". Power sequencers shall provide power conditioning and surge protection.
- G. Video System Installation Requirements:

1. The Contractor shall confirm calculations for the optimal distance from the screen to the projector lens based on actual field conditions and submit to the Architect/Engineer for review and approval.
2. If the projector and screen are in a fixed position, the Contractor shall provide the appropriate lens for the throw distance.
3. Video display image shall fill screen area with native aspect ratio

H. Audio System Installation Requirements:

1. The Contractor shall perform calculations for the optimal speaker tap settings to reach the desired SPL level and coverage without overloading the amplifier(s).
 - a. At a minimum, the following calculations shall be used:
 - 1) Add together all speaker taps that will be on a single channel of the amplifier. Multiply that total by 1.2, which will allow for a 20% future expansion. Multiply that number by 1.25 to ensure the amplifier never exceeds 75% of its total output. Utilize the final number to determine the minimum amplifier power requirements.
 - 2) For direct coupled systems (low impedance), allow a minimum of 10 dB headroom before any distortion occurs at the amplifier input indicator when beginning gain stage tests are set up. Increase headroom as appropriate for high impact and clarity needs, typically exceeding 12 to 15 dB during continuous operation.
2. Connections of balanced to unbalanced equipment shall only be done through an active converter at the unbalanced side.
3. Connections of unbalanced to balanced equipment shall only be done through an active converter at the unbalanced side.
4. Connections from stereo balanced or unbalanced equipment to mono equipment of the same signal type shall only be done through a passive combiner.
5. Connections from mono balanced or unbalanced equipment to stereo equipment of the same signal type shall only be done through a passive divider.
6. The Contractor shall provide an isolation transformer for any balanced or unbalanced audio line that exhibits a hum, noise from EMI or RFI, power line noise, or ground loops.
7. The Contractor shall provide an active audio line driver for all balanced and unbalanced signals that exceed the distance limitations of the cabling.

I. Control System Installation Requirements:

1. The Contractor shall perform calculations for the required wire AWG size based on distance for system power for touch panels, keypads and other devices being powered. A minimum of a 15% overhead is required.

3.4 VIDEO SYSTEM TESTING AND CALIBRATION

- A. All video equipment shall receive proper testing and configuration.
- B. Color Space Optimization:

1. The Contractor shall set the color space of each source and display device to a uniform color space to optimize the switching speed and compatibility of a digital video system. Each device shall be set to an RGB or YCbCr color space depending on the systems primary function and compatibility of the devices.
 2. If the primary function of the space is video and other digital media, the color space of each device shall be set to a YCbCr color space. If the primary function of the space is computer-based graphics and presentations, the color space of each device shall be set to an RGB color space.
 3. Chroma subsampling shall be set to a consistent 4:4:4 or 4:2:2 across all devices. Set to 4:4:4 when all equipment is capable.
 4. If all devices are not capable of displaying a certain color space, all devices shall be set to a common shared color space.
- C. Extended Display Identification Data (EDID) Management:
1. The Contractor shall set the EDID management tables in capable equipment so all sources output the highest common EDID table of the displays (sinks).
 2. For systems with capable matrix switches, the matrix shall dynamically adjust its EDID tables so any source will output the highest common EDID table of the displays (sinks) being outputted to.
 3. If any source or Owner-furnished equipment (OFE) is not outputting properly, the Contractor shall provide and install an EDID Emulator and set it to the highest common EDID table of the displays (sinks) being outputted to.
- D. Projectors, monitors and receivers shall be tested and adjusted for proper signal sync, convergence, brightness, contrast, and color level. The Contractor shall adjust all other parameters necessary to achieve a proper video image.
- E. All video source selections shall be tested and verified.
- F. All projectors and displays shall have a minimum burn-in time of 96 hours prior to any adjustments are made and the completion of the project
- G. All projectors and displays shall have their hue/tint and color/saturation calibrated with a video signal test generator and blue lens filter after a minimum warmup time of 20 minutes. Provide all calibrated settings results for each projector and display in the final documentation.
- H. All projectors and displays shall have their brightness, contrast and sharpness calibrated with a video signal test generator after a minimum warmup time of 20 minutes. Provide all calibrated settings results for each projector and display in the final documentation.
- I. All dynamic contrast functions shall be turned off.
- J. The Contractor shall utilize a portable oscilloscope to set video output gain and peaking levels on all line drivers and receivers for analog signals.
1. The Contractor shall submit screen shots of the fixed signal.
 2. Calibration by eye is not acceptable.

K. Full video calibration for all projectors and displays shall be provided with the following minimum requirements:

1. The Contractor shall utilize non-contact professional video calibration tools such as Sencore OTC1000-CM ColorPro Optical Tri-stimulus Colorimeter or Klein K-10 Tri-stimulus CIE Colorimeter, Sencore or Extron Video Generator and the latest version of ColorPro by CalMan software or pre-approved equal.
2. The projector or display shall have a minimum burn-in time of 96 hours prior to calibration.
3. The projector or display shall have a minimum warmup time of 20 minutes before calibration begins. All efforts shall be taken to allow the display to warm up for a minimum of 60 minutes to allow the luminance to fully stabilize.
4. The space shall be as dark as possible. The colorimeter's ambient light sensor filter shall be recalibrated every 30 minutes when outside ambient light is present to account for the changes in daylight levels.
5. All inputs utilized on the projector or display shall be calibrated using the appropriate video signal, aspect ratio and resolution. Submit results for each input as a separate report.
6. The projector or display shall be calibrated to the Rec. 709 HDTV color standard. White balance shall be calibrated as close as possible to the D65 point for both high IRE and low IRE levels.
7. The projector or display shall have its 3D Color Management calibrated.
8. The projector or display shall have its brightness and contrast adjusted both before and after the gamma is calibrated.
9. Gamma shall be calibrated to an average of 2.2. Gamma shall be verified after the calibration is completed and readjusted as necessary.
10. The projector or display shall have its hue/tint and color/saturation calibrated with a blue lens filter.
11. For calibrating 3D projectors and displays, the matching 3D glasses shall be secured to the front of the Colorimeter "looking" through the glasses for the 3D mode calibration only.
12. Record the full on/full off contrast ratio both before and after calibration. Provide these results in the final documentation.
13. The Contractor shall submit the final calibration results to the Architect/Engineer for approval and include the approved results in final documentation submitted to the Owner.
14. Calibration by eye is not acceptable.
15. Any setting that cannot be calibrated because the projector or display lacks the functions shall be noted in the final documentation.
16. For video wall applications, or where multiple projectors or displays that will share content are being used within a single space, all displays after calibration shall be adjusted to match the lowest performing projector or display so all projectors or displays are uniform. If a projector or display differs greatly from the other displays, that projector or display shall be replaced at no cost to the Owner and recalibrated.

3.5 AUDIO SYSTEM TESTING AND CALIBRATION:

- A. This Contractor shall field adjust any surface-mounted or flown loudspeaker orientation to achieve the necessary coverage pattern to the intended listening plane. Loudspeakers always face listeners and minimize coverage on walls. The contractor shall be familiar with the named and specified nominal coverage angle of all speakers above its crossover point or for speech range, (500-4,000 Hz).

- B. All speakers shall be tested for polarity prior to high work and a table of test results shall be included for A/E inspection. All loudspeakers shall be connected with uniform polarity, where a positive pressure pulse at the input corresponds to a positive driver excursion, and all drivers are uniform always moving in the same direction. Main speakers shall not be lifted or hoisted into high access areas without polarity testing.
- C. The Contractor shall make incremental adjustments on the equipment output and input tolerances to achieve matching signal levels while preserving +10 dB minimum headroom and also unity gain. Insert all broadband or high pass filters first for system protection after review of manufacturers specifications for power and bandpass.
- D. The Contractor shall utilize a Real Time Audio (RTA) spectrum analyzer with AES2 Broadband pink noise at a minimum of 1/3 octave, capable of providing detailed plots and reports.
 - 1. The Contractor shall have and own a calibrated Type 1 or Type 1.5 microphone for all measurements, that is recently calibrated within the last year.
 - 2. Calibration by ear, tablets and portable phones with integrated microphones are never acceptable. All software analysis tools require a calibrated interface and calibrated microphone. No Android devices are used for metering or calibration. IOS devices with calibrated software and interfaces may be used.
- E. Provide high quality media with full bandpass program material for critical listening. MP3 or streaming audio is not acceptable. Testing shall illustrate WAV file quality playback for impact and clarity.
- F. The Contractor shall provide graphic plots of the reference ambient noise for each space at the time of the calibration and submit with the calibration results. Test signal shall be 10dB minimum above ambient noise levels during testing.
- G. The Contractor shall use a listener sitting height of four (4) feet \pm 1" for rooms where the primary function will be sitting. The Contractor shall use a listener standing height of five feet three inches (5.25') \pm 1" for rooms where the primary function will be standing

3.6 AUDIO SYSTEM PERFORMANCE REQUIREMENTS

- A. The Contractor shall test and provide documents verifying all the following performance criteria. The Architect/Engineer shall be informed when the testing will take place and have the option to witness the testing and ask for additional testing for any reason.
- B. The Contractor shall develop an Audio Coverage Uniformity Measurement Location (ACUML) plan for each required space based on the project floor plans, and submit to the Architect/Engineer for review and approval prior to testing. The plan shall represent the majority of the listening area and perimeter seating in the direct field of main speakers.
- C. The tests shall be performed at the multiple locations defined on the ACUML plan representing the majority of the listening area(s). The Contractor shall indicate on the floor plan drawings where each test was performed, with the corresponding graphic plot, and submit with the final documentation for review and approval by the Architect/Engineer.

D. The test shall be taken with AES2 Broadband pink noise at a minimum of 15 dB above the reference ambient noise level, taking caution to not overdrive and clip any component of the system beyond 0.5% Total Harmonic Distortion (THD), with a maximum system THD of 1.0%.

E. The audio system(s) shall meet the following minimum requirements:

1. Achieve a total average SPL of 95 dBA in the majority of seating area with additional headroom. Use dBC for levels above 95 dBA.
2. The system's total SPL frequency response shall be within ± 4 dB from 500 Hz to 8000 Hz. All efforts shall be made to equalize the system's frequency response possible throughout the system's entire 100 Hz to 16kHz spectrum.
3. All vocal microphones shall have high and low pass filters set to minimize rumble, pop and hiss. The high pass filter cutoff frequency shall be set between 125 and [160] <Insert> Hz, with a [12] <Insert> dB per octave slope, minimum. The low pass filter cutoff frequency shall be set at [12,000] <Insert> Hz, with a 6 dB per octave slope. Adjust frequency and slope as required to maximize performance for both male and female voices.
4. The subwoofer/speaker low/high crossover points shall be a Butterworth (BW) filter set at 80 Hz with a 24 dB per octave slope. This crossover point shall be adjusted as needed to achieve a smooth frequency response. The subwoofer high-pass filter shall be set to manufacturer's recommended half-power point or 40 Hz, whichever is higher.
5. Achieve a minimum RaSTI value of 0.63.

3.7 DSP-BASED AUDIO PROCESSOR PROGRAMMING

A. Full system programming shall be provided for the system. Programming shall be performed by a factory trained and certified programmer or an employee of the equipment manufacturer.

B. DSP pathfile with initial settings shall be provided by the Contractor for review by the Architect/Engineer before installation.

C. The IP-based audio (IEEE AVB, Dante, etc.) and components shall be on a dedicated Virtual LAN (VLAN) for the A/V systems. These components shall be on a dedicated subnetwork of the VLAN. The Contractor shall coordinate these requirements with the Owner prior to installation.

D. A parametric EQ shall be provided after each crossover point or as approved in the DSP pathfile during shop submittal review. These shall be utilized to set the speaker output as defined in the Audio System Calibration section within this specification. These equalizers should not be made available to the user to adjust.

E. Levelers, compressor/limiters, duckers, gates and delays shall be preset during testing and commissioning and are not available for user adjustment following commissioning.

1. Adjust delays for time of flight plus 8 to 10 ms, typical.

F. Provide each microphone input with high-pass filter, 5-band parametric EQ, auto-leveler and volume module. Provide line level inputs with high-pass filter, 3-band parametric EQ, compressor/limiter, and volume module.

G. Acoustic Echo Cancelation (AEC) shall be provided for each conference microphone input.

- H. A broadband pink noise generator shall be provided with a selectable on/off control button within the DSP pathfile. The noise shall be routable through all processing EQs and speaker outputs during testing.
 - I. Provide volume meters with labeling for each input and each output.
 - J. Provide with user control software to be installed on Owner-provided and installed computer.
 - K. The Contractor shall utilize the latest version of the programming software.
 - L. The Contractor shall ensure that all components are updated to the latest firmware at the completion of the project.
- 3.8 DSP-BASED AUDIO PROCESSOR CONTROL SOFTWARE PROGRAMMING
- A. Full system software programming shall be provided for the system. Programming shall be performed by a factory-trained and certified programmer or an employee of the equipment manufacturer.
 - B. The Contractor shall schedule a series of meetings with the Owner and Architect/Engineer to define and determine the exact page layout requirements prior to the final configuration of the audio system. An Owner sign-off of the final layouts shall be required.
 - C. The Contractor shall use the latest version of the software.
 - D. At a minimum, there shall be password-protected pages for zone combining, input/output volume control with meters, speaker output volume control with meters, signal routing, signal processing (EQ's, feedback suppression, etc.), and supervision/maintenance for all spaces and combined zones.
 - E. A 15% programming dollar allowance shall be included for Owner and Architect/Engineer comments on additional system functionality as construction progresses. This shall be shown as a separate line item in the bid (include hours).
- 3.9 MULTIMEDIA CONTROL SYSTEM INTEGRATION AND PROGRAMMING
- A. Programming and Integration for Control Systems:
 - 1. Full system programming shall be provided for the system. Programming shall be performed by a factory trained and certified programmer or an employee of the equipment manufacturer.
 - 2. The Contractor shall schedule a series of meetings with the Owner and Architect/Engineer to define and determine the exact integration requirements of the control system prior to the installation of the control system and components. An Owner sign-off of the final configuration shall be required.
 - 3. This section only defines the minimum requirements. The programmer shall provide complete programming for a fully functional system.
 - 4. The Contractor shall utilize the latest version of the programming software.
 - 5. The Contractor shall ensure that all components are updated to the latest firmware at the completion of the project.

6. The IP-based control system and controlled components shall be on a dedicated Virtual LAN (VLAN) for the A/V systems. These components shall be on a dedicated subnetwork of the VLAN. The Contractor shall coordinate these requirements with the Owner prior to installation.
7. Integration and programming of the following pieces of equipment shall be provided, with the following minimum features and functions:
 - a. All equipment shall include on/off control, except for equipment that must remain active for system functionality.
 - b. Integration of HDCP (High-bandwidth Digital Content Protection) and DPCP (Display Port Content Protection) protected content and sources:
 - 1) No protected sources or content shall be allowed to be selected to route through non-protected devices and displays. A warning shall be displayed stating this information to the user.
 - c. Crestron C2N-SPWS300 Power Supply Integration:
 - 1) The Contractor shall provide Cresnet connections and programming with the following minimum functions:
 - a) On/off status of all outputs
 - b) Voltage level of all outputs
 - c) Ambient temperature and fault status
 - d. Matrix Switcher Integration:
 - 1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:
 - a) On/off control of the matrix switcher.
 - b) Allow for independent video routing of individual video inputs to any audio number of audio outputs.
 - c) Allow for audio follow video switcher mode.
 - d) Allow for independent audio routing of individual audio inputs to any audio number of audio outputs.
 - e) Provide source detection of video inputs.
 - f) HDCP (High-bandwidth Digital Content Protection) and DPCP (Display Port Content Protection) Protection:
 - g) For HDCP/DPCP - compliant sources; switcher shall only allow for routing of signals to HDCP compliant devices.
 - h) For HDCP/DPCP - complaint switchers; room combining/uncombining features shall allow for complete audio and /or video devices to be connected to the system using a simplified interface.
 - e. DSP Audio Processor Integration:
 - 1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

- a) On/off control of all microphones.
 - b) Volume and mute control of all microphones and input sources.
 - c) Volume and mute control of all outputs.
 - d) Independent volume and mute control of all assisted listening outputs.
 - e) On/off and reset control of feedback eliminators and suppressors.
 - f) Advanced routing of audio signals.
 - g) Audio conferencing dialer keypad with speed dials.
 - h) Audio conferencing CallerID display on touchpanel and/or workstation.
 - i) Acoustic Echo Cancellation (AEC) control.
- f. Audio Conference Integration:
- 1) Refer to DSP Audio Processor Integration for requirements.
- g. Projector Integration:
- 1) The projectors shall be integrated into the A/V control system via bi-directional RS-232 or Ethernet control. Provide with the following minimum functions:
 - a) On/off control.
 - b) Lamp status feedback.
 - c) Filter status feedback.
 - d) Source switching control.
 - e) Audio volume control with mute.
 - f) Video mute.
 - g) Auto image.
- h. Display Integration:
- 1) The displays shall be integrated into the A/V control system via bi-directional RS-232 or Ethernet control. Provide with the following minimum functions:
 - a) On/off control.
 - b) Display status feedback.
 - c) Source switching control.
 - d) Audio volume control with mute.
 - e) Video mute.
 - f) Tuner channel control with direct channel access.
 - g) Station presets with station icons.
- i. Motorized Projection Screen Integration:
- 1) Screens shall be integrated into the A/V control system via contact closures OR bi-directional RS-232 or Ethernet control.
 - a) Up/down and stop control shall be provided.
- j. Projector/Flat Panel Display Lift Integration:

- 1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:
 - a) Up/down and stop control shall be provided.
 - b) Service position control shall be provided (if capable).

- k. Video Conference/Telepresence Integration:
 - 1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:
 - a) Refer to DSP Audio Processor Integration for audio requirements.
 - b) Video conferencing dialer keypad with speed dials.
 - c) PTZ near end camera control.
 - d) PTZ far end camera control with lockout control at the far end.
 - e) Multi-window control with multiple presets the contractor shall coordinate with the Owner and users on designed layouts. All system inputs shall be selectable for each window.

- l. Pan/Tilt/Zoom (PTZ) Camera Integration:
 - 1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:
 - a) Provide full pan, tilt and zoom control.
 - b) Provide presets for fixed camera positions, contractor shall coordinate with the Owner for desired preset positions.

- m. Document Camera/Visualizer Integration:
 - 1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:
 - a) The Contractor shall provide, at a minimum, power on and off functions as well as zoom and focus functions.
 - b) Bulb life and equipment status shall be monitored (if available).

- n. DVD/Blu-ray and/or VCR Player Integration:
 - 1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:
 - a) Typical DVD/Blu-ray and/or VCR functions shall be provided.
 - b) Real time metadata (if available).
 - c) Player status feedback.
 - d) Provide standard Blu-ray menu navigation Red, Green, Blue and Yellow buttons, in that order, for touch panel-based systems.

- o. DVD/Blu-ray and/or VCR Recorder Integration:

- 1) The Contractor shall provide IR based control or Ethernet control system connections and programming with the following minimum functions:
 - a) Typical DVD/Blu-ray and/or VCR functions shall be provided with the additions of start/stop recording and finalize disk.
 - b) Any input to the system shall be selectable to be recorded, except for protected and copyrighted content. A warning shall be displayed on the touch panel when a protected source is active and not able to be recorded.
 - c) Real time metadata (if available).
 - d) Player status feedback.

- p. CD Player/Changer Integration:
 - 1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:
 - a) Typical CD player functions shall be provided.
 - b) Direct disk load 0-9 numbers.
 - c) Direct track 0-9 selections.
 - d) Real time metadata (if available).

- q. Multi-channel Receiver Integration:
 - 1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:
 - a) Power on/off control.
 - b) Audio/video source select.
 - c) XM/Sirius/FM/AM tuner direct station access and preset access.
 - d) Master volume control with mute.
 - e) Surround sound mode.
 - f) Real time metadata.
 - g) Receiver status feedback.

- r. TV Tuner Integration:
 - 1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:
 - a) Channel up/down control.
 - b) Direct type in channel access.
 - c) Provide a channel shortcut page with station icons for each channel the Owner chooses, including IPTV channels. Contractor shall coordinate with Owner the desired channels for presets.
 - d) Provide real time metadata and schedule information for display on the touch panel.

- s. Digital Video Recorder (DVR) Integration:

- 1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:
 - a) Camera selection buttons to view individual cameras.
 - b) Pan/Tilt/Zoom (PTZ) control for applicable cameras.
 - c) Record start, stop and playback control.
 - d) All other required control for normal DVR functions and operations.
 - e) This defines only the basic integration requirements.

- t. XM/Sirius/FM/AM Tuner Integration:
 - 1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:
 - a) Provide real time metadata for display on the touch panel
 - b) Provide with XM, Sirius, FM and AM channel presets with icons.
Contractor shall coordinate with Owner the desired channels for presets.
 - c) Full tuner control and direct channel control shall be provided.

- u. Uninterruptible Power Supply (UPS) Integration:
 - 1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:
 - a) The control system shall provide monitoring and readouts for the following: Power mode, battery maintenance status, battery charge status, battery time remaining, internal temperature, current line voltage, min/max voltages, and output voltage/load.
 - b) The control system shall provide a pop-up warning if any status item exceeds or falls below its threshold.
 - c) Upon loss of power or sustained under voltage for more than thirty (30) seconds, the control system shall begin a shutdown sequence of projectors and other heat-sensitive, active-cooled equipment.

- v. Power Sequencer Integration:
 - 1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:
 - a) Power on/off control.
 - b) On/off status via +12VDC output from the sequencer to the I/O input of the control system processor.

- w. Digital Audio Mixing Board Integration:
 - 1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:
 - a) On/off control of device.
 - b) Master volume control.

- c) Scene or preset recall.
 - d) This defines only the basic integration requirements. Coordinate with Owner on additional required functions.
- x. Multi-window Processor Integration:
 - 1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:
 - a) All system inputs shall be selectable for each window of the processor.
 - b) Multiple pre-configured window presets shall be provided.
 - c) The Contractor shall coordinate with the Owner and users on desired layouts.
- y. Divisible Room Integration and Programming:
 - 1) The following represents the minimum integration and programming requirements for divisible rooms.
 - a) The touch panel shall show a grid or map of the rooms and spaces that are combinable.
 - b) The user shall be able to highlight a group of rooms or spaces in any combination and hit combine.
 - c) Once combined, all functions shall operate as a single space including, but not limited to, master audio volume control and lighting.
 - d) All input sources shall be selectable to be output to any combination of displays.
 - e) Once rooms are combined all speaker volume levels shall normalize and all volume controls shall adjust the system as a whole.
 - f) Once rooms are combined all lighting levels shall normalize and all lighting controls shall adjust the system as a whole.
- z. Lighting Integration:
 - 1) Lighting shall be integrated into the A/V control system via bi-directional RS-232 or Ethernet control. The A/V contractor shall coordinate with the lighting control contractor for full system integration.
 - 2) Basic scene presets shall be provided for different presentation modes.
 - a) The A/V contractor shall schedule a meeting to coordinate with the Owner and lighting control contractor for desired scene presets.
 - 3) A master dimmer shall be provided.
 - 4) This defines only the basic integration requirements.
 - 5) Refer to the Electrical Lighting Integration Section 26 0933 for additional information.
- aa. Shade Integration:

- 1) Shades shall be integrated into the A/V control system via bi-directional RS-232 or Ethernet control. The A/V contractor shall coordinate with the shade control contractor for full system integration.
 - 2) Basic scene presets shall be provided for different presentation modes.
 - a) The A/V contractor shall schedule a meeting to coordinate with the Owner and shade control contractor for desired scene presets.
 - 3) A master variable open and close shall be provided.
 - 4) This defines only the basic integration requirements.
 - 5) Refer to the Electrical Lighting Integration Section 26 0933 for additional information.
- bb. Divisible Room Motorized Divider Integration:
- 1) Dividers shall be integrated into the A/V control system via contact closures OR bi-directional RS-232 or Ethernet control. The A/V contractor shall coordinate with the divider control contractor for full system integration.
 - 2) Basic presets shall be provided for all different required configurations.
- cc. Ambient Light Sensor Integration:
- 1) Sensors shall be integrated into the A/V control system via 0-10V analog signal, digital logic level, or proprietary control signal, with the following minimum functions:
 - a) When the space's ambient light, both natural and manmade, falls below the threshold, the spaces projector(s) shall automatically go into low power mode or high-power mode if the light level rises above the threshold. An override on the touch panel shall be made available.
 - b) If there are multiple sensors within a single space, all sensors shall average together.
- dd. Partition Sensor Integration:
- 1) Sensors shall be integrated into the A/V control system via 0-10V analog signal, digital logic level, or proprietary control signal, with the following minimum functions:
 - a) When the partition is open, the rooms shall automatically combine. When the partition is closed, the rooms shall automatically separate. An override on the touch panel shall be made available.
 - b) If more than one sensor is on a single partition, all sensors shall read the same status before their intended function is performed.
- ee. Occupancy Sensor Integration:
- 1) Sensors shall be integrated into the A/V control system via 0-10V analog signal, digital logic level, or proprietary control signal, with the following minimum functions:

- a) When the sensor(s) first sense motion, the touch panel shall automatically activate and light up.
- b) When the sensor(s) stops sensing motion after the defined time limit, a warning message shall pop up on the touch panel warning the user that the room will automatically go into standby mode.
- c) An override button shall be present during the duration of the warning message to reset the time limit.
- d) If the warning is not acknowledged, the system shall entire a standby mode.
- e) If more than one sensor is in a single space, all sensors shall read the same status before their intended function is performed.

ff. HVAC Temperature Display and Control Integration:

- 1) BAS HVAC temperature readouts and control shall be integrated into the A/V control system via RS-232/422/485, Ethernet, or proprietary BAS control protocol with a conversion module that converts the proprietary control to standards compliant RS-232/422/485 or Ethernet. Provide the following minimum functions:
 - a) The touch panel shall display the spaces current temperature and set temperature.
 - b) The touch panel shall have temperature up and down buttons.
 - c) The touch panel shall display the exterior temperature.

B. Programming and Configuration for Touch Panels:

1. This section only defines the minimum requirements. The programmer shall provide complete touch panel layouts and programming for a fully functional system.
2. The Contractor shall schedule a series of meetings with the Owner and Architect/Engineer to define and determine the exact touch panel layout requirements prior to the purchase and installation of the touch panels. An Owner sign-off of the final layouts shall be required.
 - a. Some tabs, pages, buttons and functions may be required to have a password at the Owner's discretion. This shall be coordinated during the meetings.
3. Contractor logos are not allowed on the touch panels. The Contractor shall coordinate with the Owner on desired logos to be displayed.
4. All programming for interface and control of all devices shown on the drawings shall be provided. Programming shall be provided for the following minimum functionality:
 - a. The main screen shall include graphical buttons for the primary room functions.
 - 1) Upon selection of the graphical button, all the required functions shall be displayed on the screen. All required equipment shall turn on.
 - b. Master System On/Off Control:

- 1) When the master system off button is selected, all capable components within the system shall be turned off or placed on standby, except for equipment that is required to remain on for the system to function like the control system processor.
 - c. The main screen shall include graphical buttons for the selection of individual source selections.
 - 1) Upon selection of the graphical button for a source selection, all functional controls for the pieces of equipment, as well as all status indicators, shall be provided in graphical format on the screen.
 - 2) Rooms with multiple independent outputs and displays shall have a source routing matrix to allow any input to be routed to any output.
 - d. The main screen shall include a button for advanced equipment status and monitoring.
 - 1) Upon selection of the graphical button, the page shall display the on/off status of all monitored equipment, projector lamp hours, projector filter status, and all other features listed within this section that require monitoring
 - e. The main screen shall include a button for microphone volume control and muting.
 - 1) Upon selection of the graphical button, it shall display the individual volume level of each wired and wireless microphone, with a mute for each.
 - 2) Rooms with multiple independent audio outputs and zones shall have a source routing matrix to allow any input to be routed to any output or zone.
 - f. At all times, on all screens, a button shall be provided to return to the main screen, except for modal pop-ups.
 - g. A master volume control and mute shall be provided at all times on all screens, except for modal pop-ups.
 - h. A master video mute shall be provided at all times on all screens, except for modal pop-ups and audio-only functions.
 - i. A modal countdown timer shall be displayed showing the warmup and cooldown time of the projector. All functions shall be locked out while the projector is in cooldown mode.
 - j. All unused hard buttons shall not be labeled. A blank touch panel bezel shall be provided if no hard buttons are used.
5. Room scheduling touch panels shall provide the following minimum functions:
- a. The touch panel shall display the room name, room number, date, and time at all times in a clearly visible font.
 - b. Display Microsoft Outlook calendar day view with the ability to look up other available rooms and book a room directly from the touch panel.
 - c. The border of the touch panel and/or touch panel buttons shall be green when the room is available and red when the room is in use.
 - d. A door chime icon shall be provided to sound a tone through the room's interior touch panel.

- 1) The interior touch panel shall have an Enter or Do Not Enter button that displays the answer on the exterior to the room touch panel or scheduling panel.
- e. The interior touch panel shall have a Do Not Disturb (DND) button that disables or replaces the exterior scheduling touch panel's chime button.
- f. All unused hard buttons shall not be labeled. A blank touch panel bezel shall be provided if no hard buttons are used.

C. Touch Panel Layout Principles, Considerations and Guidelines:

1. Icons and Buttons:

- a. Icons shall not be used solely as a button but can be embedded in a button.
- b. Icons shall appear to be flat and unpressable.
- c. Status bars or text windows for time, date, room number, and similar information shall appear to be slightly depressed into the screen and appear to be unpressable.
- d. Buttons shall appear to be pressable by appearing to come off the screen with beveled edges, lighting gradients, and shadows. When pressed, the button shall appear to be depressed into the screen.
 - 1) Buttons that are momentary shall change color when pressed, appear to depress, then pop back up and revert to the original button color and state.
 - 2) Buttons that are not momentary shall change color when pressed, appear to depress, remain depressed, then pop back up, and revert to the original button color and state when pressed again.
- e. Buttons and icons shall appear to be lit from the top left corner of the screen.
- f. Buttons shall be grouped together according to general function.
- g. Button size shall be based on the ratio of Phi (1:1.618) and be sized appropriately based on the screen area and dpi (pixel pitch).
- h. Maintain a minimum of 5 to 10 pixels between buttons on small to medium touch panels, and a minimum of 10 to 15 pixels between buttons on medium to large touch panels.
- i. Telephone dialer keypads shall be based on the ITU-T E.161/ANSI TI-703 standard telephone layout and include the a-z letters below each appropriate number.
- j. TV and radio tuner keypads shall be based on the ITU-T E.161/ANSI TI-703 standard telephone layout, except for the asterisk (*) being replaced by a dot (.) and the pound (#) being replaced with Enter.
- k. IP-address keypads shall be based on the standard computer keyboard 10-key numeric keypad typically found on the right side of the keyboard.
- l. Buttons such as Power, Play, Stop, Record, Rewind, Previous, Forward, Eject, Return, Next, Up, Down, Left, Right, Plus, Minus, etc. shall use standard industry symbols. Record shall always be a solid red circle.

2. Text and Fonts:

- a. The Contractor shall use a standard sans-serif bold Arial or Calibri font style unless the Owner dictates otherwise.

- b. Words shall have the first letter capitalized and the rest of the word lower case. No words shall be all capitals or all lower case. Follow standard grammatically correct sentence structure where the first word is capitalized and the rest of the sentence is lower case, followed by the appropriate punctuation mark with accurate syntax and correct verbs.
 - c. All font size in a single group or cluster shall maintain the same font size. Headers to a group or cluster shall have a slightly enlarged font size. and footers shall have a slightly smaller font size in comparison to the group font size to maintain a visual hierarchy.
 3. Color Considerations:
 - a. Colors shall be selected so that, when converted to monochrome, all text, buttons, icons, groups, clusters, borders, etc. are clearly visible to accommodate all color blind or color-impaired individuals and ADA requirements.
 - b. Background colors shall be cool low saturation colors such as grey, blue, or green and their analogous colors, and be a gradient from top down or top left to bottom right.
 - c. Base colors shall be analogous to the background color but be of a higher saturation to stand out more clearly.
 - d. Button colors shall be analogous to the background color, stand out clearly from the base colors, and be of a higher saturation cool color, gray, or a low saturation black.
 - e. Icon, symbols, and text color shall be a neutral white or black, or a low saturation grey, and shall clearly stand out from the background or button it is placed on.
 - f. Buttons for modal acknowledgement, exit or return, or other modal action shall be a warm color such as red or yellow and their analogous colors.
 - g. Buttons, icons, symbols or text for emergency or urgent notifications shall be bright red.
 4. Pages and Background:
 - a. Groups and clusters shall have clearly defined borders, with spacing between adjacent groups.
 - b. Modal pop-up windows or pages shall be required when a command requires user input before it is executed or when a button has multiple nested elements to control, such as microphone volumes, zone control, lighting and environment control, advanced system controls, etc.
 - 1) The modal pop-up pages shall dim and grey out the background and buttons, overlay the main page, and have a clear back or exit button to bring the user back into the active page the user was on before the modal pop-up.
 - 2) A model pop-up timer page shall appear when a projector is being turned on or off for the appropriate warmup or cooldown time. No additional commands shall be allowed during this time.
 - 3) Model pop-ups shall not replace or completely overlay the background.
 - c. Images or pictures shall never be used as backgrounds to any page other than a master start page, if appropriate.
 5. Medium to Large Format Touch Panel Layout Guideline Template:

- a. IMAGEClient Logo - Static Window
 - b. A/V Source Selection - Static Window
 - c. Display Power, Screen Controls, Light Controls, Shade Controls, and other Environmental Controls - Static Window
 - d. Controls for Selected Source and Status or Home Page - Dynamic Window
 - e. Master Volume and Mute, Video Mute, and Microphone Volume - Static Window
 - f. Home Button - Static Window
 - g. Date, Time, and Room Number - Static Window
 - h. Master System Off - Static Window
6. Small Format Touch Panel Layout Guideline Template:
- a. A/V Source Selection and Source Control and Status After Selection - Dynamic Window
 - b. Home Button - Static Window
 - c. Date, Time, and Room Number - Static Window
 - d. Master System Off - Static Window
7. Small Format Room Scheduling Touch Layout Guideline Template
- a. Room Schedule and Scheduling Control - Dynamic Window
 - b. Chime Button - Static Window
 - c. Date, Time, and Room Number - Static Window
- D. Programming and Configuration for Keypads:
1. This section only defines the minimum requirements. The programmer shall provide complete keypad layouts and programming for a fully functional system.
 2. Full system programming and configuration shall be provided for the system. Programming and configuration shall be performed by a factory-trained and certified programmer or an employee of the equipment manufacturer.
 3. This section only defines the minimum requirements. The programmer shall provide complete programming and configuration for a fully functional system.
 4. The Contractor shall utilize the latest version of the programming and configuration software.
 5. The Contractor shall ensure that all components are updated to the latest firmware at the completion of the project.
 6. All programming and configuration for interface and control of all devices shown on the drawings shall be provided. Programming and configuration shall be provided for the following minimum functionality:
 - a. A master system on and off button.
 - 1) All capable components within the system shall be turned off or placed on standby when the system is selected to be off.
 - b. A master volume control up/down buttons or knob and a mute
 - c. Source select or source toggle button(s).
 - d. DVD/VCR control including, but not limited to, play, pause, stop, fast forward, rewind and chapter forward and reverse.

- e. Screen up and down control.
 - f. TV channel up and down control.
 - g. All unused hard buttons shall not be labeled.
- E. A [15%] <Insert> [programming dollar allowance shall be included for Owner and Architect/Engineer comments on additional system functionality as construction progresses. This shall be shown as a separate line item in the bid (include hours).]
- 3.10 CENTRALIZED CONTROL SYSTEM ASSET MANAGEMENT SOFTWARE PROGRAMMING
- A. A Centralized Control Asset Management System shall be provided to integrate all IP-based control systems for remote control, monitoring, troubleshooting and statistics.
 - B. The workstation(s) and/or server(s) shall be [Owner] <Insert> provided and [Owner] <Insert> installed. The Contractor shall provide, install, and program all software specified and required. The Contractor shall coordinate with the Owner on the Owner's preferred operating system, antivirus, and all other required software to be installed on the workstation(s) and/or server(s). Refer to manufacturer recommendations for computer workstation and server requirements and ensure the Owner is aware of and complies to these recommendations.
 - C. The Contractor shall coordinate with the Owner on the location of the preferred file server for the central database files to which the workstations will connect.
 - D. The Centralized Control Asset Management System shall be on the same dedicated Virtual LAN and subnetwork as the control systems. The Contractor shall coordinate these requirements with the Owner prior to installation.
 - E. The Contractor shall provide, install and configure the software on up to three (3) workstations of the Owner's choosing.
 - F. Integration to Microsoft Exchange Version Insert shall be provided, installed, configured, and programmed.
 - 1. The Contractor shall provide and install add-in software for Microsoft Outlook for direct user access to server scheduling.
 - 2. The Contractor shall train and assist the Owner in creating basic email templates for various notifications.
 - G. Integration to Microsoft Active Directory/LDAP shall be provided, installed, configured, and programmed.
 - 1. The Contractor shall train and assist the Owner in creating user access levels.
 - H. The system shall be based on latest version of server/cloud-based software.
 - I. A series of meetings shall be scheduled by the Contractor with the Owner, Architect/Engineer, and control system manufacturer to determine all required functions, reports and statistics to be utilized. An Owner sign-off of the final layouts and configuration shall be required. At a minimum, provide the following:

1. Hardware polling for system diagnostics.
 2. Processor "on line" status.
 3. Rooms system on/off status.
 4. Display presence.
 5. Display on/off status.
 6. On/off switching capabilities with log of devices used.
 7. Which devices are in use.
 8. Event/error codes.
 9. Lamp status.
 10. Equipment fault or out of tolerance status
 11. Filter status.
 12. Room scheduling with on/off control of system.
 13. Scheduling of digital signage displays including video walls on/off control and status (if digital signage system is not capable of scheduling and controlling the displays).
 14. Status of lights in room (if applicable).
 15. Motion detection in room (if applicable).
 16. Log of audio and video conference numbers and IP addresses.
 17. Room temperature and humidity (if applicable).
 18. Reporting features would be included for the following:
 - a. Lamp life.
 - b. Room system usage statistics.
 - c. Device usage statistics.
 19. Room scheduling touch panel integration shall be provided with the following minimum features:
 - a. Room name, room number, date, and time data.
 - b. Microsoft Outlook calendar integration with the ability to look up other available rooms and book a room directly from the touch panel.
 - c. Room in use or available status.
 20. Crestron Green Light software add-in package for RoomView Server Edition shall be included and integrated.
- J. A series of meetings shall be scheduled by the Contractor with the Owner, Architect/Engineer, and control system manufacturer to determine all required functions, reports, and statistics to be utilized. An Owner sign-off of the final layouts and configuration shall be required. At a minimum, provide the following:
1. Hardware polling for system diagnostics.
 2. Processor "on line" status.
 3. Rooms system on/off status.
 4. Display presence.
 5. Display on/off status.
 6. On/off switching capabilities with log of devices used.
 7. Which devices are in use.
 8. Event/error codes.
 9. Lamp status.
 10. Equipment fault or out of tolerance status

11. Filter status.
 12. Room scheduling with on/off control of system.
 13. Scheduling of digital signage displays including video walls on/off control and status (if digital signage system is not capable of scheduling and controlling the displays).
 14. Status of lights in room (if applicable).
 15. Motion detection in room (if applicable).
 16. Log of audio and video conference numbers and IP addresses.
 17. Room temperature and humidity (if applicable).
 18. Reporting features would be included for the following:
 - a. Lamp life.
 - b. Room system usage.
 - c. Device usage.
 19. Room scheduling touch panel integration shall be provided with the following minimum features:
 - a. Room name, room number, date and time data.
 - b. Microsoft Outlook calendar integration with the ability to look up other available rooms and book a room directly from the touch panel.
 - c. Room in use or available status.
- K. The system shall be based on manufacturer's latest version of enterprise software.
- L. A series of meetings shall be scheduled by the Contractor with the Owner, Architect/Engineer, and control system manufacturer to determine all required functions, reports, and statistics to be utilized. An Owner sign-off of the final layouts and configuration shall be required. At a minimum, provide the following:
1. Hardware polling for system diagnostics.
 2. Processor "on line" status.
 3. Rooms system on/off status.
 4. Display presence.
 5. Display on/off status.
 6. On/off switching capabilities with log of devices used.
 7. Which devices are in use.
 8. Event/error codes.
 9. Lamp status.
 10. Filter status.
 11. Equipment fault or out of tolerance status
 12. Room scheduling with on/off control of system.
 13. Scheduling of digital signage displays including video walls on/off control and status (if digital signage system is not capable of controlling the displays).
 14. Status of lights in room (if applicable).
 15. Motion detection in room (if applicable).
 16. Log of audio and video conference numbers and IP addresses.
 17. Room temperature and humidity (if applicable).
 18. Reporting features would be included for the following:
 - a. Lamp life.

- b. Room system usage.
- c. Device usage.

M. The Contractor shall include Extron's GlobalViewer for Pocket PC for Windows-based PDAs and smart phones.

3.11 SYSTEM COMMISSIONING

A. The Contractor shall notify the Architect/Engineer and Owner prior to conducting final system commissioning.

B. .

C. System verification testing is part of the commissioning process. Verification testing shall be performed by the Contractor and witnessed and documented by the Commissioning Agent. Refer to Section 01 0900 - General Commissioning for system verification tests and commissioning requirements.

D. Contractor shall demonstrate system performance of all equipment and adjust settings as directed by the Architect/Engineer and/or Owner.

- 1. All system settings, software options and other parameters shall be simulated and tested by the Contractor

3.12 FIELD QUALITY CONTROL

A. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product that meets the requirements of the specifications, as supplied and warranted by the system vendor. If the product or assembly is not available from the system vendor, provide product or assembly as recommended by the system vendor.

B. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the Contract Documents.

3.13 FIELD SERVICES

A. The installer shall conduct a planning meeting with the Owner. The purpose of this meeting shall be to determine all equipment settings that are considered preferences (where proper system operation does not depend on the setting).

B. The installer shall include labor for all planning and all programming activities required to implement the Owner's preferences for equipment settings.

C. It shall be the responsibility of the Contractor/installer to provide a complete, functional system as described by the design documents. These responsibilities include:

- 1. Complete hardware setup, installation and wiring and software configuration.
- 2. Complete programming of software in accordance with the Owner's desires determined by the planning meeting.

3. Complete system diagnostic verification.
4. Complete system commissioning.

3.14 SYSTEM ACCEPTANCE

- A. The Contractor shall submit for review a formal acceptance and system checkout procedure. The system checkout procedures shall include all system components and software. The Contractor shall perform the tests and settings and document all results.

3.15 SYSTEM DOCUMENTATION

- A. Complete documentation shall be provided for the system. The documentation shall describe:
 1. All operational parameters of the system.
 2. Complete documentation of programming and features.
 3. Complete operating instructions for all hardware and software.
- B. The following sections shall be provided in the system documentation:
 1. User Manual: A step-by-step guide and instructions detailing all system user functions.
 2. Technical Manual: A comprehensive document providing all system operations, troubleshooting flowcharts, functional system layout, wiring diagrams, block diagrams and schematic diagrams.
 3. Maintenance Manual: A comprehensive document on all aspects of physical maintenance of the systems, including cleaning of the displays, bulb changes, filter cleaning, filter changing and UPS maintenance.

3.16 PROJECT CLOSEOUT

- A.

3.17 SYSTEM TRAINING

- A. All labor and materials required for on-site system training shall be provided. Training shall be conducted at the project site using the project equipment.
 1. Provide two week's advanced notice of training to the Owner and Architect/Engineer.
 2. The Architect/Engineer shall be presented with the option to attend the training.
 3. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.
- B. At a minimum, the following training shall be conducted:
 1. User Manual: A course detailing the system functions and operations that a daily user will encounter.
 2. Technical User: Provide configuration training on all aspects of the system(s), including equipment and software.
 3. Maintenance User: Provide training on all aspects of physical maintenance of the systems, including cleaning of the displays, bulb changes, filter cleaning and filter changing.

C. Minimum on-site training times shall be:

1. User Manual: One (1) day.
2. Technical user: One (1) day.
3. Maintenance user: Four (4) Insert hours.
4. The Contractor shall include in his/her bid one (1) additional day of training each quarter for the 12-month period of the project warranty. The Contractor shall return to the site for additional follow-up training during this period.

END OF SECTION

SECTION 28 0500 - BASIC ELECTRONIC SAFETY AND SECURITY SYSTEM REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Basic Safety and Security System Requirements (herein referred to Security) specifically applicable to Division 28 sections, in addition to Division 1 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 SCOPE OF WORK

- A. This Specification and the accompanying drawings govern the work involved in furnishing, installing, testing and placing into satisfactory operation the security systems as shown on the drawings and specified herein.
 - B. Each Contractor shall provide all new materials as indicated in the schedules on the drawings, and/or in these specifications, and all items required to make the portion of the security systems a finished and working system.
 - C. Separate contracts will be awarded for the following work.
 - D. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.
 - E. Separate contracts will be awarded for the following work. The division of work listed below is for the contractors' convenience and lists a normal breakdown of the work. Please refer to the Construction Manager's scope statements for complete scope of work description.
 - F. Description of systems include but are not limited to the following:
 - 1. Electronic access control system
 - 2. Electronic intrusion detection system
 - 3. Video surveillance
4. Fire detection and alarm.
- 5. Low voltage security wiring (less than +120VAC) as specified and required for proper system control and communications.
 - 6. All associated electrical backboxes, conduit, miscellaneous cabling, and power supplies required for proper system installation and operation as defined in the "Suggested Matrix of Scope Responsibility".
 - 7. Firestopping of penetrations of fire-rated construction as described in Section 28 0503.

1.3 DIVISION OF WORK BETWEEN ELECTRICAL AND SECURITY CONTRACTORS

A. Division of work is the responsibility of the Prime Contractor. Any scope of work described in the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described in the contract documents. The following division of responsibility is a guideline based on typical industry practice.

B. Definitions:

1. "Electrical Contractor" as referred to herein refers to the Contractors listed in Division 26 of this Specification.
2. "Electrical Contractor" shall also refer to the Contractor listed in Division 28 of this specification when the "Suggested Matrix of Scope Responsibility" indicates the work shall be provided by the EC. Refer to the Contract Documents for the "Suggested Matrix of Scope Responsibility".
3. "Security Contractor" as referred to herein refers to the Contractors listed in Division 28 of this Specification.
4. Low Voltage Security Wiring: The wiring (less than 120VAC) associated with the Security Systems, used for analog and/or digital signals between equipment.

C. General:

1. The purpose of these Specifications is to outline typical Electrical and Security Contractor's work responsibilities as related to security systems including back boxes, conduit, power wiring and low voltage security wiring. The prime contractor is responsible for all divisions of work.
2. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals are approved. Therefore, only known wiring, conduits, raceways, and electrical power as related to such items, is shown on the Security Drawings. Other wiring, conduits, raceways, junction boxes, and electrical power not shown on the Security Drawings but required for the successful operation of the systems shall be the responsibility of the Security Contractor and included in the Contractor's bid.
3. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of Security systems, the final installation shall not begin until a coordination meeting between the Electrical Contractor and the Security Contractor has convened to determine the exact location and requirements of the installation.
4. Where the Electrical Contractor is required to install cable tray that will contain Low Voltage Security Wiring, the installation shall not begin until the Security Contractor has completed a coordination review of the cable tray shop drawing.
5. This Contractor shall establish Electrical and Security utility elevations prior to fabrication and installation. The Security Contractor shall cooperate with the Electrical Contractor and the determined elevations in accordance with the guidelines below. This Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
 - a. Lighting Fixtures
 - b. Gravity Flow Piping, including Steam and Condensate

- c. Sheet Metal
- d. Electrical Busduct
- e. Cable Trays, including 12" access space
- f. Sprinkler Piping and other Piping
- g. Conduit and Wireway
- h. Open Cabling

D. Electrical Contractor's Responsibility:

1. Assumes all responsibility for all required conduit and power connections when shown on the "Suggested Matrix of Scope Responsibility" to be provided by the Electrical Contractor.
2. Assumes all responsibility for providing and installing cable tray.
 3. Responsible for Security Systems grounding and bonding.
 4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Security Contractor's Responsibility:

1. Assumes all responsibility for the low voltage security wiring of all systems, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being provided by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility."
3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined herein).
4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of security equipment which is required to be bonded to the telecommunications bonding system.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other contractors to determine a viable layout.

1.4 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
 - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.

- b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - d. Maintenance clearances and code-required dedicated space shall be included.
 - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
 2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
 - a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
 3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.
- B. Participation:
 1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
 2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
 - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
 3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.
- C. Drawing Requirements:
 1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.

- a. Scale of drawings:
 - 1) General plans: 1/4 Inch = 1'-0" (minimum).
 - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
 - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
 - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
 - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
 - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
 - b. Potential layout changes shall be made to avoid additional access panels.
 - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.

- d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
 - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain signoff of the drawings by all contractors prior to installing any of the components.
 11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
 12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer will be acceptable.
2. Each Contractor and their subcontractors shall employ only workers who are skilled in their respective trades and fully trained. All workers involved in the installation, termination, testing, and placing into operation electronic security devices shall be individually trained by the manufacturer.
3. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.
4. The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of electronic security devices and have personnel adequately trained in the use of such tools and equipment.
5. A resume of qualification shall be submitted with the Contractor's bid indicating the following:
 - a. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.

B. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City of Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all published standards of .
3. In the event there are no local codes having jurisdiction over this job, the current issue of the National Electrical Code shall be followed.
4. If there is a discrepancy between the codes and regulations having jurisdiction over this installation, and these specifications, Architect/Engineer shall determine the method or equipment used.
5. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time to follow this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.

6. Verify the installation environment prior to purchasing or installing any cable. Cable installed in a plenum environment shall be appropriately rated. Bring all discrepancies between the contract documents and installation conditions to the attention of the Architect/Engineer prior to purchase or installation.
 7. All changes to the system made after the letting of the contract, in order to comply with the applicable codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.
- C. Permits, Fees, Taxes, Inspections:
1. Procure all applicable permits and licenses.
 2. Abide by all applicable laws, regulations, ordinances, and other rules of the State or Political Subdivision wherein the work is done, or as required by any duly constituted public authority.
 3. Pay all applicable charges for such permits or licenses that may be required.
 4. Pay all applicable fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
 5. Pay all charges arising out of required inspections due to codes, permits, licenses or as otherwise may be required by an authorized body.
 6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized independent agency/consultant.
 7. All equipment, and materials shall be as approved or listed by the following: (Unless approval or listing is not applicable to an item by all acceptable manufacturers.)
 - a. Underwriters' Laboratories, Inc.
- D. Examination of Drawings:
1. The drawings for the Security Systems work are diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment etc., and the approximate sizes of equipment.
 2. Contractor shall determine the exact locations of equipment and the exact routing of cabling to best fit the layout of the job. Scaling of the drawings will not be sufficient or accurate for determining this layout. Where a specific route is required, such route will be indicated on the drawings.
 3. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
 4. If an item is either shown on the drawings, called for in the specifications or required for proper operation of the system, it shall be considered sufficient for including same in this contract.
 5. The determination of quantities of material and equipment required shall be made by the Contractor from the drawings. Schedules on the drawings and in the specifications are completed as an aid to the Contractor but where discrepancies arise, the greater number shall govern.
 6. Where words "provide", "install", or "furnish" are used on the drawings or in the specifications, it shall be taken to mean, to furnish, install and terminate completely ready for operation, the items mentioned.
- E. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
 4. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
 5. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
 6. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
 7. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

F. Field Measurements:

1. Before ordering any materials, this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.

Referenced Specification Section	Submittal Item	Coordination Drawings
28 05 03	Through-Penetration Firestopping	
28 13 00	Electronic Access Control	
28 16 00	Intrusion Detection System	Yes
28 23 00	Video Surveillance	Yes
28 26 05	Rescue Assistance Communication System	
28 26 13	Infant Protection System	

1.6 CHANGE ORDERS

- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.
- B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.
- C. Change order work shall not proceed until authorized.

1.7 EQUIPMENT SUPPLIERS' INSPECTION

- A. The following equipment shall not be placed in operation until a representative of the manufacturer has inspected the installation and certified that the equipment is properly installed and that the equipment is ready for operation:

- 1. Firestopping, including mechanical firestop systems.

1.8 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

- A. Exercise care in transporting and handling to prevent damage to fixtures, equipment and materials.
- B. Store materials on the site to prevent damage.
- C. Keep fixtures, equipment and materials clean, dry and free from harmful conditions.

1.9 NETWORK / INTERNET CONNECTED EQUIPMENT

- A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.10 WARRANTY

- A. At a minimum, provide a one (1) year warranty for all equipment, materials, and workmanship. Individual specifications sections within Division 28 may require additional warranty requirements for specific equipment or systems.
- B. The warranty period for the entire installation described in this Division of the specifications shall commence on the date of substantial completion unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner or their representative.
- C. Warranty requirements shall extend to correction, without cost to the final user, of all work and/or equipment found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from such defects or nonconformance with contract documents exclusive of repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

1.11 INSURANCE

- A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

1.12 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required.
- B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meets all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors. The Architect/Engineer shall make the final determination of whether a product is equivalent.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor bears full responsibility for the unnamed manufacturers' equipment adequately meeting the intent of design. The Architect/Engineer may reject manufacturer at time of shop drawing submittal. The Contractor assumes all costs incurred by other trades on the project as a result of changes necessary to accommodate the offered material, equipment or installation method.
- D. Should this Contractor be unable to secure approval from the Architect/Engineer for other unnamed manufacturers as outlined above, this Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder. Should a voluntary alternate material be accepted, This Contractor shall assume all costs that may be incurred as a result of using the offered material, article or equipment necessitating extra expense on This Contractor or on the part of other Contractors whose work is affected.

PART 2 - PRODUCTS

2.1 Refer to individual sections.

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Installation of all conduit and cabling shall comply with Sections 26 05 33 and 26 05 13. Additional conduit requirements described within this Division shall be supplemental to the requirement described in Section 26 0533. Should conflicts exist between the two Divisions the more stringent (more expensive material and labor) condition shall prevail until bidding addendum or construction clarification or RFI can be submitted and responded to. In no case shall the Contractor carry the least stringent condition in the pricing.
- B. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.
- C. The Contractor shall be responsible for identifying and reporting to the Architect/Engineer any existing conditions including but not limited to damage to walls, flooring, ceiling and furnishings prior to start of work. All damage to interior spaces caused by this Contractor shall be repaired at this Contractor's expense to pre-existing conditions, including final colors and finishes.
- D. All cables and devices installed in damp or wet locations, including any underground or underslab location, shall be listed as suitable for use in such environments. Follow manufacturer's recommended installation practices for installing cables and devices in damp or wet locations. Any cable or device that fails as a result of being installed in a damp or wet location shall be replaced at the Contractor's expense.

3.3 FIELD QUALITY CONTROL

- A. General:
1. Refer to specific Division 28 sections for further requirements.

2. The Contractor shall conduct all tests required and applicable to the work both during and after construction of the work.
3. The necessary instruments and materials required to conduct or make the tests shall be supplied by the Contractor who shall also supply competent personnel for making the tests who has been schooled in the proper testing techniques.
4. In the event the results obtained in the tests are not satisfactory, This Contractor shall make such adjustments, replacements and changes as are necessary and shall then repeat the test or tests which disclose faulty or defective work or equipment, and shall make such additional tests as the Architect/Engineer or code enforcing agency deems necessary.

B. Protection of cable from foreign materials:

1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.
2. Application of foreign materials of any kind on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

3.4 PROJECT CLOSEOUT

- A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.
- B. Final Jobsite Observation:
 1. The Architect/Engineer will not perform a final jobsite observation until the project is ready. This is not dictated by schedule, but rather by completeness of the project.
 2. Refer to the end of Section 27 0500 for a "STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION."
 3. The Contractor shall sign this form and return it to the Architect/Engineer so that the final observation can commence.
- C. Before final payment will be authorized, this Contractor must have completed the following:
 1. Submitted operation and maintenance manuals to the Architect/Engineer for review.

2. Submitted bound copies of approved shop drawings.
 3. Submitted a report stating the instructions given to the Owner's representative complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representative as having received the instructions.
 4. Submitted testing reports for all systems requiring final testing as described herein.
 5. Submitted start-up reports on all equipment requiring a factory installation inspection and/or start.
6. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site; submit receipt to Architect/Engineer prior to final payment being approved.

3.5 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. Transmittal file name: O&Mtransmittal.div28.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.

8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

3.6 INSTRUCTING THE OWNER'S REPRESENTATIVE

- A. Adequately instruct the Owner's designated representative or representatives in the maintenance, care, and operation of the complete systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representative or representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.

3.7 SYSTEM STARTING AND ADJUSTING

- A. The security systems included in the construction documents are to be complete and operating systems. The Architect/Engineer will make periodic job site observations during the construction period. The system start-up, testing, configuration, and satisfactory system performance is the responsibility of the Contractor. This shall include all calibration and adjustments of electrical equipment controls, equipment settings, software configuration, troubleshooting and verification of software, and final adjustments that may be required.
- B. All operating conditions and control sequences shall be simulated and tested during the start-up period.
- C. The Contractor, subcontractors, and equipment suppliers are expected to have skilled technicians to ensure that the system performs as designed. If the Architect/Engineer is requested to visit the job site for the purpose of trouble shooting, assisting in the satisfactory start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period through no fault of the design; the Contractor shall reimburse the Owner on a time and material basis for services rendered at the Architect/Engineer's standard hourly rates in effect at the time the services are requested. The Contractor shall be responsible for making payment to the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.8 RECORD DOCUMENTS

- A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.
- B. Mark specifications to indicate approved substitutions, change orders, and actual equipment and materials used.

- C. This Contractor shall maintain at the job site, a separate and complete set of Security Drawings which shall be clearly and permanently marked and noted in complete detail any changes made to the location and arrangement of equipment or made to the Technology Systems and wiring as a result of building construction conditions or as a result of instructions from the Architect or Engineer. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should This Contractor fail to complete Record Documents as required by this contract, This Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.
- D. Record actual routing of all conduits sized 2" or larger.
- E. The above record of changes shall be made available for the Architect and Engineer's examination during any regular work time.
- F. Upon completion of the job, and before final payment is made, This Contractor shall give the marked-up drawings to the Architect/Engineer.

3.9 ADJUST AND CLEAN

- A. Contractor shall thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.
- B. Contractor shall clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from equipment.
- C. Contractor shall remove all rubbish, debris, etc., accumulated during the Contractor's operations from the premises.

3.10 CONSTRUCTION WASTE MANAGEMENT

- A. This Contractor shall comply with all construction and demolition waste disposal and recycling requirements outlined in LEED MRc2: Construction Waste Management (follow latest edition at the time of bidding or as referenced in these specifications).
 - 1. This Contractor shall coordinate with the General Contractor to develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on-site or co-mingled.
 - 2. The Contractor shall track waste disposal and recycling efforts throughout the construction process for all materials associated with this Contractor's scope of work. The Contractor shall provide this information to the General Contractor so that it can be incorporated with similar information from all other contractors for the project.
 - a. Calculations for waste and recycled material can be done by weight or volume, but they must be consistent throughout the project. The Contractor shall coordinate with the General Contractor to establish the preferred calculation method and report the results accordingly.

- b. Excavated soil and land-clearing debris do not count towards the waste disposal or recycled material.
- 3. At a minimum, 50% of the construction and demolition debris for this project must be recycled or salvaged.

STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION

To assist the contractor in a timely close-out of the project, it is crucial that the final jobsite observation is not conducted prior to the project being ready. The contractor is required to review the completion status of the project at the time the observation is scheduled. This review, and the subsequent submittal of this form to the Architect/Engineer, shall indicate the contractor's agreement that the area of the project being requested for final observation is ready as defined below. The following list represents the degree of completeness required prior to requesting a final observation:

- 1. All cabling pathways (cable tray, ladder rack, conduit sleeves, etc.) are installed and all cabling has been pulled through them.
- 2. All mechanical firestop products are installed and all other penetrations have been sealed.
- 3. All CCTV cameras, mounts, cabling and all headend equipment are installed, programmed and operational.
- 4. All access control system equipment, including card readers, conduits, cabling, electronic locks, controllers and all headend equipment, is installed, programmed and operational.

Prime Contractor: _____ By: _____

Requested Observation Date _____ Today's Date: _____

Contractor shall sign this readiness statement and transmit to Architect/Engineer at least 10 days prior to the requested date of observation.

It is understood that if the Architect/Engineer finds that the project is not complete as defined above and that the final jobsite observation cannot be completed on the requested date, the Architect/Engineer will return to the site at a later date. All additional visits to the site for the purposes of completing the final observation will be billed T&M to the Contractor at our standard hourly rates, including travel expenses or the contractor's retainage may be deducted for the same amount.

END OF SECTION

SECTION 28 0503 - THROUGH PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 REFERENCES

- A. UL 263 - Fire Tests of Building Construction and Materials
- B. UL 723 - Surface Burning Characteristics of Building Materials
- C. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
- D. UL 2079 Tests for Fire Resistance of Building Joint Systems
- E. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
- F. Intertek / Warnock Hersey - Directory of Listed Products
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- H. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
- I. HCAI - Health Care Access and Information (California)
- J. The Building Officials and Code Administrators National Building Code
- K. 1997 Uniform Building Code
- L. Wisconsin Administrative Code
- M. NFPA 5000 - Building Construction Safety Code

1.2 SUBMITTALS

- A. Submit under provisions of Section 28 0500.
- B. Submit Firestopping Installers Certification for all installers on the project.
- C. Shop Drawings: Submit for each condition requiring firestopping. Include descriptions of the specific penetrating item, actual wall/floor construction, manufacturer's installation instructions, and UL or Intertek / Warnock Hersey Assembly number.
- D. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:
 - 1. Types of penetrating items.
 - 2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.

3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.
- E. Maintain a notebook on the job site at all times that contains copies of approved submittals for all through penetration firestopping to be installed. Notebook shall be made available to the Authority Having Jurisdiction at their request and turned over to the Owner at the end of construction as part of the O&M Manuals.
- 1.3 DELIVERY, STORAGE, AND HANDLING
- A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.
 - B. Install material prior to expiration of product shelf life.
- 1.4 PERFORMANCE REQUIREMENTS
- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
 1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
 2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
 - B. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
 - C. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
 - D. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.
- 1.5 MEETINGS
- A. Pre-installation meeting: A pre-installation meeting shall be scheduled and shall include the Construction Manager, General Contractor, all Subcontractors associated with the installation of systems penetrating fire barriers, Firestopping Manufacturer's Representative, and the Owner.
 1. Review foreseeable methods related to firestopping work.
 2. Tour representative areas where firestopping is to be installed; inspect and discuss each type of condition and each type of substrate that will be encountered, and preparation to be performed by other trades.

1.6 WARRANTY

- A. Provide one year warranty on parts and labor.
- B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.
 - 1. 3M; Fire Protection Products Division
 - 2. Specified Technologies Inc. (S.T.I.)

2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

- A. Provide materials and systems classified by or listed by Intertek / Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.
- B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.
- C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.
- D. Firestopping systems for plumbing and wet pipe sprinkler piping shall be moisture resistant.
- E. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.
- F. Provide firestopping systems allowing continuous insulation for all insulated pipes.
- G. Provide firestopping systems classified by UL or listed by Intertek / Warnock Hersey for penetrations through all fire rated construction. Firestopping systems shall be selected from the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory Category XHEZ based on substrate construction and penetrating item size and material and shall fall within the range of numbers listed:

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	FC 0000-0999*
Metallic Pipe or Conduit	FC 1000-1999
Non-Metallic Pipe or Conduit	FC 2000-2999
Electrical Cables	FC 3000-3999

<u>Penetrating Item</u>	<u>UL System No.</u>
Cable Trays	FC 4000-4999
Insulated Pipes	FC 5000-5999
Bus Duct and Misc. Electrical	FC 6000-6999
Duct without Damper and Misc. Mechanical	FC 7000-7999
Multiple Penetrations	FC 8000-8999
*Alternate method of firestopping is patching opening to match original rated construction.	

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	WL 0000-0999*
Metallic Pipe or Conduit	WL 1000-1999
Non-Metallic Pipe or Conduit	WL 2000-2999
Electrical Cables	WL 3000-3999
Cable Trays	WL 4000-4999
Insulated Pipes	WL 5000-5999
Bus Duct and Misc. Electrical	WL 6000-6999
Duct without Damper and Misc. Mechanical	WL 7000-7999
Multiple Penetrations	WL 8000-8999
*Alternate method of firestopping is patching opening to match original rated construction.	

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	CAJ 0000-0999*
Metallic Pipe or Conduit	CAJ 1000-1999
Non-Metallic Pipe or Conduit	CAJ 2000-2999
Electrical Cables	CAJ 3000-3999
Cable Trays	CAJ 4000-4999
Insulated Pipes	CAJ 5000-5999
Bus Duct and Misc. Electrical	CAJ 6000-6999
Duct without Damper and Misc. Mechanical	CAJ 7000-7999
Multiple Penetrations	CAJ 8000-8999
*Alternate method of firestopping is patching opening to match original rated construction.	

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.

- B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.
- C. Surfaces to which sealing materials are to be installed must meet the selected UL or Intertek / Warnock Hersey system substrate criteria.
- D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

3.2 INSTALLATION

- A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Intertek / Warnock Hersey listed firestopping system is installed.
- B. Install penetration seal materials in accordance with printed instructions of the UL or Intertek / Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.
- C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

3.3 CLEANING AND PROTECTING

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

3.4 IDENTIFICATION

- A. Provide and install labels adjacent to each firestopping location. Label shall be provided by the firestop system supplier and contain the following information in a contrasting color:
 - 1. The words "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Firestop System Supplier; UL or listed by Intertek / Warnock Hersey system number; date installed; contractor name and phone number; manufacturer's representative name, address, and phone number.

3.5 INSPECTION

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.
- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.
- D. The contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the contractor and witnessed by the engineer and manufacturer's factory representative. The engineer shall have sole discretion of which firestop system installations will be reviewed. The contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the engineer's discretion and the contractor's expense.

END OF SECTION

SECTION 28 1300 - ELECTRONIC ACCESS CONTROL

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 08 7100 - Door Hardware
- B. Section 26 0513 - Wire and Cable
- C. Section 26 0533 - Conduits and Boxes
- D. Section 26 0535 - Surface Raceways
- E. Section 27 0526 - Communications Bonding
- F. Section 27 0528 - Interior Communication Pathways
- G. Section 27 0543 - Exterior Communication Pathways
- H. Section 27 0553 - Identification and Administration
- I. Section 27 1500 - Horizontal Cabling Requirements
- J. Section 28 0500 - Basic Electronic Safety and Security System Requirements.
- K. Section 28 0503 - Through Penetration Fire stopping.
- L. Section 28 1600 - Intrusion Detection System
- M. Section 28 2300 - Video Surveillance
- N. Section 28 2613 - Infant Protection System
- O. Section 28 3100 - Fire Detection and Alarm Systems.

1.2 QUALITY ASSURANCE

- A. Manufacturer: The manufacturer shall have a minimum of ten (10) years documented experience in the development and manufacture of access control software and hardware. The software developer shall be, at a minimum, a Microsoft Silver Certified Integrator and Partner for those systems that reside in a Microsoft environment.
- B. Contractor:
 - 1. Shall be a factory-authorized installation, service and support company specializing in the selected manufacturer's product, with demonstrated prior experience of a minimum of ten (10) years installing, programming and supporting the selected manufacturer's system.

2. Shall have been in business for a minimum of ten (10) years and shall have installed a minimum of three (3) similar or larger sized systems. Contractor shall have a minimum of two (2) service technicians who are certified in the proposed manufacturer's system.
3. Shall[have as a regular, full time employee][retain the services of] a minimum of one employee with the following certification(s) or education [Should more than one certification be required, one employee may maintain multiple certifications.]
 - a. A certification of RCDD from BICSI or CNIDP from CNet.
 - b. A certification of MCSA: Server or MCSE: Server Infrastructure from Microsoft.
 - c. A certification of CCENT or CCNA from CISCO. CCNP certification satisfies either of these requirements.

C. Material:

1. All material which is Contractor furnished shall be new, unused and free from defects.
2. Where more than one of any specified item of equipment or material is used, all such items shall be the same product from the same manufacturer.

1.3 REFERENCES

- A. International Building Code
- B. NFPA 70 - National Electrical Code.
- C. The BOCA National Building Code
- D. UL 294 - Standard for Access Control Systems.
- E. UL 365 - Standard for Police Station Connected Burglar Alarm Units and Systems.
- F. UL 464 - Standard for Audible Signal Appliances.
- G. UL 603 - Standard for Power Supplies for Use with Burglar Alarm Systems.
- H. UL 609 - Standard for Local Burglar Alarm Units and Systems
- I. UL 634 - Standard for Connectors and Switches for Use with Burglar Alarm Systems.
- J. UL 827 - Standard for Central Station Alarm Services.
- K. UL 1076 - Standard for Proprietary Burglar Alarm Units and Systems.
- L. UL 1449 - Standard for Surge Protective Devices.
- M. UL 1635 - Standard for Digital Alarm Communicator Systems.
- N. UL 1638 - Standard for Visual Signaling Appliances – Private Mode Emergency and General Utility Signaling.
- O. UL 1778 - Uninterruptible Power Systems.

1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 28 0500.
- B. Product Data Submittal: Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:
 - 1. Compliance with each requirement of these documents. The submittal shall acknowledge each requirement of this section, item-by-item.
 - 2. All component options and accessories specific to this project.
 - 3. Electrical power consumption rating and voltage[including UPS sizing].
 - 4. Heat generation for all power consuming devices.
 - 5. Wiring requirements.
 - 6. Server processor(s), workstation configurations, total and available disk space, and memory size.
 - 7. All network bandwidth, latency and reliability requirements.
 - 8. Backup/archive system size and configuration.
 - 9. Submit two of each type of credential to be used (access card, key fob, etc.).
- C. System Drawings: Project-specific system CAD drawings shall be provided as follows:
 - 1. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (e.g., multiple identical controllers), the diagram may show one device and refer to the others as "typical" of the device shown. The diagram shall list room numbers where each controller will be located. This block diagram shall be provided in Adobe PDF.
 - 2. Provide a schedule of all controllers and the doors/points each controller controls. This schedule shall be provided in Adobe PDF.
 - 3. Provide schedules describing each system input location by an architecturally familiar reference, e.g., Door 312A. The architectural door schedule shall be used as the basis. These schedules shall be provided in Adobe PDF
- D. Submit sample format of site specific programming guides to be used for system planning/programming conference with Owner. These guides shall be provided in Adobe PDF.
- E. So that required Owner personnel are present at the planning/programming conference required in Part 3 of this section, submit meeting agenda for the conference a minimum of two weeks prior to the conference.
- F. Submit detailed description of Owner training to be conducted at project end, including specific training times. Refer to Part 3 of this section for details.
- G. IP Addresses: Contractor shall provide to Owner, in a documented transmittal and in Microsoft Excel format, the names and locations of devices which require an IP address. An authorized representative of the Owner shall furnish the addresses for the associated devices in Microsoft Excel format in a documented transmittal. Should Owner change the IP address structure after approval of the list, Owner may be responsible for additional fees involved with reprogramming.

1.5 SYSTEM DESCRIPTION

- A. This section describes the furnishing, installation, programming and commissioning of a complete, turnkey access control system. The terms "access control system" and "security management system", or SMS, may be used interchangeably herein.
- B. The company, manufacturer, and product names used in this section are for identification purposes only. All trademarks and registered trademarks are the property of their respective owners.
- C. Performance Statement: This section and the accompanying access control-specific design documents are performance based, describing the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment constraints described and the performance required of the system, as presented in these documents, the vendor and the Contractor are solely responsible for determining all wiring, programming, and miscellaneous equipment required. The Contractor shall be responsible for determining quantities of materials required for a complete and operational system. Floor plan drawings and schedules have been developed to aid the Contractor in determining device quantities and installation locations, but, where discrepancies between floor plans and schedules arise, the greater number shall govern.
- D. Basic System Description:
1. The access control system shall provide the following functionality:
 - a. Electronic control access to designated areas.
 - b. Validation of cardholder credentials by use of personnel database, card formats. The system shall compare the time, location, and unique credentials of an attempted entry with information stored in the database.
 - c. Access to designated areas will be validated only when a user's credential has a valid number for its facility and the number is valid for the current time and for the reader where it is used.
 - d. The system software shall access the hardware that validates the person and monitors the security of a building by use of intelligent system controllers, reader interfaces, locks, readers, inputs and outputs. When access has been validated, a signal to the portal locking device shall be activated to enable alarm free access at that location.
 - e. The system shall be configured by use of application software.
 - f. The system shall monitor activities using operator monitoring software which includes graphical maps which display alarms, status and activity.
 - g. The system shall differentiate and restrict administrative and operational access through use of password authentication.
 - h. The system shall report on various aspects of the system by use of reports, both default and customizable. Reports shall be able to be printed.
 - i. The system shall have the capability to report alarms both audibly and visually.
 - j. The system shall control hardware from the monitoring station by use of manual actions and events.
 - k. The system shall provide record and data management by use of journals. There shall be a full audit trail.

- l. The system shall allow for data to be imported from other products by use of database migration tools. These products may include Human Resources databases for name and/or time and attendance information, information from previous access control systems consisting of badge numbers from credentials that will be re-used, Microsoft Excel spreadsheets, or other systems as defined herein.
 - m. The system shall allow access using a web interface or a mobile application for use on the iOS and Android operating systems.
- E. Integrations, Software Development Kit (SDK) and Application Programming Interface (API):
1. The manufacturers of the systems that are integrated shall make an SDK available to other manufacturers.
 2. Prior to the release of this section, the manufacturers of the systems that are to be integrated shall have made available to each other all APIs to perform the specific integrated functions required in this section.
 3. The integrations shall be completed and tested, and shall have been implemented on at least one system of similar size prior to the release of this section. The integrations shall not be accomplished for the first time for this project unless written pre-approval has been granted by Owner to Contractor prior to bid deadline.
 4. During the warranty period, should a new API or version of software be released by the SMS manufacturer or any of the manufacturers of systems or devices that are integrated, that API or version of software shall be installed in the appropriate system or device defined in this section at no charge to Owner. Should any loss of functionality in the integration be exposed through this installation, as compared to the accepted system, Contractor shall correct the functionality at no charge to Owner.
 5. Any and all development costs for specified functionality or inter-system integrations shall be included in the Contractor's bid. No additional costs or fees for the integrations shall be charged to Owner from the time of notice to proceed through system acceptance.

1.6 OWNER FURNISHED MATERIAL

- A. Telephone service
- B. Data circuit / internet service
- C. Active telephone service equipment, such as key system, PBX or VOIP switch equipment
- D. Active computer network equipment:
 1. Routers
 2. Switches
 3. Hubs
 4. Wireless access points
 5. Uninterruptible power supplies for Owner furnished products
- E. Active computer equipment:
 1. SMS server - refer to Part 2 for details
 2. SMS workstation(s) - refer to Part 2 for details
 3. SMS badging station(s) - refer to Part 2 for details

4. Uninterruptible power supplies for Owner furnished products

F. Credentials:

1. Badges
2. Key fobs

1.7 LICENSING REQUIREMENTS

- A. All user licenses required for system operation shall be included in the Contractor's bid. User licenses shall include server and workstation software, network controllers, card readers, printers, badging stations, and any other licensing that is required by the manufacturer for operation of any system component.

1. Licenses shall be provided on a one-to-one basis. One license shall be provided for each device requiring a license. In the event the manufacturer requires the purchase of a block of licenses, license blocks provided shall be no greater than what is required for the number of devices in this project. Contractor shall document the number of remaining licenses in the project record documents and Operations and Maintenance data.
2. In addition to the licensing requirements listed above, provide licensing and configuration of system administration/operation software for workstations. The workstation licenses shall be concurrent use seats, and the client software shall be able to be loaded on an unlimited number of workstations at no extra cost to the Owner. Contractor shall install client software on the same number of machines as licenses provided. As part of the training, Contractor shall demonstrate to Owner how to install client software on additional workstations.
3. The system described herein is an extension of an existing system. All licensing shall be new for each installed device. The Contractor shall not use any of the Owner's existing (spare) licenses for any new components.
4. The system described herein is an extension of an existing system. The existing system has licenses available for use. Contractor may use the existing licenses that are available. Once all existing licenses have been used, Contractor shall provide new licenses for remaining devices.
5. All Contractor-furnished software shall contain a perpetual, permanent license in which no other fees beyond the single payment for the work of this section are required in order to use the proposed software indefinitely. Owner understands that, after the initial warranty period has expired, maintenance and technical support fees may be required annually, quarterly, or monthly in order to receive software updates and technical support. However, it remains the option of Owner to purchase or decline this service. If Owner chooses to discontinue or never purchase this service, the software shall continue to be legally licensed for use. All software shall be the latest version released, and all Contractor-furnished servers and workstations shall be current on all patches and updates for all software on the machines at the time of acceptance of the associated systems.
6. The SMS shall require only a single license key present on the server for the SMS to operate. The key shall be a physical device or a software key. License keys shall not be required at the client workstations.

1.8 PROJECT RECORD DOCUMENTS

- A. Submit documents under the provisions of Section 28 0500.

- B. Provide final system block diagram showing any deviations from shop drawing submittal.
 - C. Provide statement that system checkout test, as outlined in the shop drawing submittal, is complete and satisfactory.
 - D. Provide schedules documenting:
 - 1. Controller installation locations including specific door numbers being controlled.
 - 2. All terminal block wiring, including cable numbers.
 - E. Warranty: Submit written warranty and complete all Owner registration forms.
 - F. Complete all operation and maintenance data manuals as described below.
- 1.9 OPERATION AND MAINTENANCE DATA
- A. Submit documents under the provisions of Section 28 0500.
 - B. Manuals: Final copies of the manuals shall be delivered within 30 days after completing the installation test. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of the contractor responsible for the installation and maintenance of the system, and the factory representatives for each item of equipment for each system. The manuals shall have a table of contents and labeled sections. The final copies delivered after completion of the installation test shall include all modifications made during installation, checkout, and acceptance testing. Manuals shall be submitted in both hardcopy and electronic format. The manuals shall consist of the following:
 - 1. Hardware Manual: The manual shall describe all equipment furnished including:
 - a. General description and specifications.
 - b. Installation and check out procedures.
 - c. System and equipment layout and electrical schematics to the control board and field device level. For multiple devices wired identically, only one wiring diagram is required per door configuration, to be labeled "TYPICAL".
 - d. Alignment and calibration procedures.
 - e. Manufacturers repair parts list indicating sources of supply.
 - 2. Software Manual: The software manual shall describe the functions of all software and shall include all other information necessary to enable proper loading, testing, and operation. The manual shall include:
 - a. Definition of terms and functions.
 - b. System use and application software.
 - c. Initializations, startup, and shutdown procedures.
 - d. Reports generation.
 - e. Details on forms customization and field parameters.
 - 3. Operator's Manual: The operator's manual shall fully explain all procedures and instructions for the operation of the system including:

- a. Computers and peripherals.
 - b. Log in/Log out procedures.
 - c. Use of system, command, and applications software.
 - d. Recovery and restart procedures.
 - e. Graphic alarm presentation.
 - f. Use of report generator and generation of reports.
 - g. Data entry.
 - h. Operator commands.
 - i. Alarm messages.
 - j. System permissions functions and requirements.
4. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, cleaning, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

1.10 WARRANTY

- A. Unless otherwise noted, provide warranty for one (1) year after date of Substantial Completion for all materials and labor.
- B. Onsite Work During Warranty Period: This work shall be included in the Contractor's bid and performed during regular working hours, Monday through Friday.
1. Inspections: The Contractor shall perform two minor inspections at six-month intervals (or more often if required by the manufacturer), and two major inspections offset equally between the minor inspections to effect quarterly inspection of alternating magnitude.
 2. Minor Inspections: These inspections shall include:
 - a. Visual checks and operational tests of all equipment, field hardware, and electrical and mechanical controls.
 - b. Mechanical adjustments if required on any mechanical or electromechanical devices.
 3. Major Inspections: These inspections shall include all work described under paragraph Minor Inspections and the following work:
 - a. Clean all equipment, including exterior surfaces and accessible and serviceable interior surfaces.
 - b. Perform diagnostics on all equipment.
 - c. Check, test, and calibrate (if required) all sensors.
 - d. Run all system software diagnostics and correct all diagnosed problems.
- C. Operation: Upon the completion of any scheduled adjustments or repairs, Contractor shall verify operation of the SMS.

- D. Service: The Owner will initiate service calls when the SMS is not functioning properly. If requested by the Owner, the Contractor shall respond or remain at the site after normal business hours, and the Owner shall reimburse the Contractor for the incremental cost difference between premium labor rates and standard labor rates. This reimbursement applies to premium labor rates that do not exceed time-and-one-half rates after normal business hours and double-time rates for Sundays and holidays. The Owner shall be furnished with telephone number(s) where service personnel can be reached 24/7/365. Qualified service personnel shall be at the site within 24 hours after receiving a request for service.
 - E. Records, Logs and Work Requests: Contractor shall keep records and logs of each task completed under and outside of warranty. These logs shall be maintained in Microsoft Word or Excel. The log shall include the model and serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, description of work performed, the amount and nature of the material used, and the time and date of commencement and completion of the work. Complete logs shall be kept and shall be available for review on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the SMS. The Contractor shall deliver a record of the work performed within three (3) business days after work is completed. Defective items that have been replaced shall be given to the Owner. Should the replacement item be a temporary replacement until the removed item is repaired, Contractor shall retain possession of the defective item for repair and subsequent re-installation.
 - F. System Modifications: Modifications by the Contractor are allowed after system acceptance. Contractor shall make recommendations for system modification in writing to the Owner. No system modifications shall be made without prior, written approval of the Owner. Any modifications made to the system shall be incorporated into the Operations and Maintenance Manuals, and other documentation affected. The Owner shall be provided with electronic restorable versions of all configurations prior to the modifications being made.
 - G. Software: At no charge, the Contractor shall provide to Owner all updates released by the manufacturer during the period of the warranty and verify operation of the system upon installation. These updates include system software updates, patches, bug fixes and revisions, as well as firmware updates. These updates shall be accomplished in a timely manner, fully coordinated with SMS administrators and operators, shall include training for the new changes/features, and shall be incorporated into the Operations and Maintenance Manuals and software documentation.
 - H. Refer to the individual product sections for further warranty requirements of individual system components.
- 1.11 ANNUAL SERVICE CONTRACT
- A. Provide annual cost for extended service and maintenance agreement after the first year for the access control system according to the following terms:

1. The term of the warranty shall begin on the system acceptance date and shall continue for one (1) year. The extended service and maintenance warranty shall begin following this first year if accepted by the Owner. The term shall be automatically renewed for successive one-year periods unless canceled in writing by the Owner with Contractor confirmed receipt, up to the date of expiration. The service and maintenance agreement shall include the following basic services to the Owner, including all necessary parts, labor and service equipment:
 - a. Repair or replace any security equipment item that fails to perform as initially installed, as specified, or as determined per the manufacturer's performance criteria.
 - b. Perform preventive maintenance on the security equipment during the 6th month and 12th month of the service contract. This preventive maintenance shall include cleaning, realignment, inspection, and testing of security devices. The Owner shall receive a written report of these inspections that identifies the security system's status and, if required, a list of all necessary repairs or replacements.
 - c. Provide maintenance on the SMS system software. At no charge, the Contractor shall provide to Owner all updates released by the manufacturer during the period of the service contract and verify operation of the system upon installation. These updates include system software updates, patches, bug fixes and revisions, as well as firmware updates. These updates shall be accomplished in a timely manner, fully coordinated with SMS administrators and operators, shall include training for the new changes/features, and shall be incorporated into the Operations and Maintenance Manuals and software documentation. Contractor shall not be responsible for maintenance of Owner data.
 2. The Contractor shall be compensated for any repairs or maintenance provided as a result of Owner abuse, misuse, intentional damage, accidental damage, or power fluctuations exceeding specified equipment tolerances.
 3. Service: The Owner will initiate service calls when the SMS is not functioning properly. If requested by the Owner, the Contractor shall respond or remain at the site after normal business hours, and the Owner shall reimburse the Contractor for the incremental cost difference between premium labor rates and standard labor rates. This reimbursement applies to premium labor rates that do not exceed time-and-one-half rates after normal business hours and double-time rates for Sundays and holidays. The Owner shall be furnished with telephone number(s) where service personnel can be reached 24/7/365. Qualified service personnel shall be at the site within <Insert> hours after receiving a request for service.
- B. Provide complete terms and conditions of warranty and service.
- C. The Owner will enter into a contract directly with the vendor. This specification section is not a contract between the Owner and the vendor to perform these services.

PART 2 - PRODUCTS

2.1 ELECTRONIC ACCESS CONTROL SYSTEM MANUFACTURERS

- A. Software House C-Cure 9000

- B. Should the access control manufacturer offer, as an option, the use of hardware by Mercury Security, the Contractor proposed solution shall utilize this hardware. Contractor shall state whether or not the software is compatible with the SCP, AP and EP families of Mercury Security hardware. For future additions or defective hardware replacements, the system shall not be "locked" to require Mercury Security hardware be purchased only from the access control software manufacturer or from the original Installing Contractor.
- C. Approval of Alternate Manufacturers:
 - 1. Contractors seeking approval for alternate manufacturers for any devices or software in this section shall submit requests for approved equals as defined by Division 1 in addition to submitting:
 - a. Bill of materials for each piece of hardware and software proposed.
 - b. Manufacturer's data sheet for each piece of equipment proposed.
 - c. Line-by-line typewritten statement of compliance or non-compliance comparing Part 2 of this section with the published specifications of the proposed alternate products. This compliance statement shall be signed by an officer of the local contractor branch office that proposes to install the alternate product and either an officer of the manufacturer or an officer of the manufacturer's representative.
 - 2. Refer to the project drawings for manufacturer and model numbers for the Basis of Design products.

2.2 SERVER

- A. The system shall not be required to have a traditional or virtual server and, instead, may be provided with embedded server functionality integral to the controller if the following three (3) conditions are met. The server specified below shall apply if the system does not meet these three (3) conditions:
 - 1. The network controller is a distributed architecture, native IP network appliance.
 - 2. The network appliance contains an onboard, embedded operating system (e.g., Linux-based), web server, ODBC-compliant database engine, data storage device and application logic controller.
 - 3. The network appliance contains onboard SSL communications.
- B. If the system architecture utilizes traditional servers, the system shall be a true multi-tasking, multi-threading application system architecture designed specifically for the Windows environment. All modules, including access control, alarm monitoring, credential management, etc., shall be built from a single unified 32-bit source code set.
- C. The system shall communicate on a TCP/IP based Ethernet LAN capable of utilizing 10/100/1000 BaseT.
- D. The system shall be functional in a virtual server environment.
- E. Provisioning:

1. The server shall be furnished by the Owner and shall meet the specifications defined by the SMS software manufacturer to meet or exceed the functionality and performance specifications of the system and integrations defined in this and related sections. Contractor shall furnish specifications to the Owner in writing as part of the submittals. Owner furnished server may be traditional or may be virtual.
2. Acceptable manufacturers of Contractor-furnished server are:
 - a. Dell -Basis of Design Power Edge R730 Series
 - b. HP
 - c. Approval of Alternate Manufacturers:
 - 1) Contractors seeking approval for alternate manufacturers for the server in this section shall submit requests for approved equals as defined by Division 1 in addition to submitting:
 - a) Bill of materials for each piece of hardware proposed.
 - b) Line-by-line typewritten statement of compliance or non-compliance comparing Part 2 of this section with the published specifications of the proposed alternate products. This compliance statement shall be signed by an officer of the local contractor branch office that proposes to install the alternate product and either an officer of the manufacturer or an officer of the manufacturer's representative.
 - 2) Refer to the project drawings for manufacturer and model numbers for the Basis of Design products.

F. Hardware:

1. Enterprise class server.
2. Rack mount configuration.
3. Six (6) USB 2.0 ports, one (1) two port 10/100/1000 Ethernet NIC.
4. Dual, redundant, hot swappable power supplies.
5. RAID Level 5 configuration with separate drives for data base, 500GB, and operating system, 500GB. One spare hot swappable hard drive for the database and one for the operating system.
6. Enterprise class hard drives, minimum 7200 RPM, 3.5" SATA, minimum mean time between failure, MTBF, 1.2 M hours, 100% duty cycle 24x7.
7. 8 GB RAM.
8. Internal DVD+/- RW ROM SATA drive.
9. On board[VGA][HDMI] video card.
10. Predictive failure analysis.
11. Two (2) cooling fan modules, each with two fans, hot swappable.
12. [Rack mount LCD monitor with integrated keyboard, touchpad and KVM switch. This monitor, keyboard and touchpad may also serve the video management system server, if present, through the KVM switch][Desk mount 19" LCD monitor, USB 101 keyboard and USB two (2) button mouse].

13. Redundant Server: The system shall maintain a primary server and a redundant backup server with mirrored database. Should the primary server fail, system control shall be automatically switched to the backup server without operator intervention. All access control field hardware shall be configured for communication with both primary and backup servers. Both primary and backup servers shall recognize the same TCP/IP address on the network. This system feature shall require two identical servers with minimum configurations as defined above.
14. Backup Power:
 - a. Owner-furnished uninterruptible power supply (UPS) with surge suppression.
 - b. Contractor-Furnished Uninterruptible Power Supply (UPS):
 - 1) Line interactive, simulated or true sine wave.
 - 2) The critical load is normally supplied by utility power, and internal batteries are simultaneously float charged. The UPS shall boost or buck the voltage as needed, caused by fluctuations in utility voltage. Upon utility power failure, the UPS shall automatically switch to supplying load power from the batteries and internal inverter.
 - 3) Manufacturers:
 - a) APC: Smart UPS Series
 - 4) Compliance:
 - a) Surge Suppression: ANSI C62.41
 - b) Safety: UL 1778
 - c) EMC: FCC Part 15
 - 5) Output rated for 3 kVA.
 - 6) Hot swappable batteries.
 - 7) Battery Capacity: Capable of operating at full load for [5][10][15][30] minutes.
 - 8) Rack mount.
 - 9) Input of 120 VAC, single phase, two wire plus ground.
 - 10) Supports external battery pack.
 - 11) Outlet Receptacles: Minimum six (6) NEMA 5-15R receptacles.
 - 12) Web browser or SNMP monitoring.
 - 13) Operating ambient temperature of 32°F to 104°F.
 - 14) Relative humidity 0% to 95% non-condensing.
 - 15) Internal input circuit breaker.
 - 16) Audible alarms for low battery warning, internal faults, overload, weak/dead battery.
 - 17) Transfer time of 6 m sec typical.
 - 18) Emergency Power Off (EPO) switch.
 - 19) Modes of Operation:
 - a) Normal/On-line - critical load is supplied by AC source, harmonics are filters and batteries are float charged
 - b) Boost - with a sag in utility power from 90 VAC to 105 VAC, UPS shall boost the voltage until AC source rises to 112 VAC

- c) Buck - with a swell in utility power ranging from 130 VAC to 150 VAC, UPS shall buck the voltage until AC source drops to 125 VAC
- d) Battery - upon failure, brownout or overvoltage of AC power, the load shall be supplied power from the UPS batteries and inverter
- e) Recharge - batteries shall be recharged to 90% capacity within 8 hours after return of normal AC power from low battery cut off
- f) DC start - UPS shall start and operate without AC power applied

G. Operating System:

- 1. Windows Server 2003 SP2 or higher

H. Database:

- 1. SQL Server 2008 R2 Express Edition

I. The SMS software shall utilize the native Windows security features and be registered with the Windows operating system as a service. The security features shall be configured with the following layers:

- 1. Workstation: Prohibits non-operators from accessing the system.
- 2. Desktop: Controls which applications a given operator can run.
- 3. Applications Commands: Controls which commands within an application a given operator can perform.
- 4. Files: Controls an operator's read/write access rights to individual files.
- 5. Breakthrough Alarms: The operating system shall allow high priority alarm condition notification regardless of the application software currently opened.

J. Upgrades or expansion of the SMS to a larger size system in scale shall not require installation of a different and/or new SMS application or require the administrator/operator to learn a different and/or new interface from the previous version.

K. Associated Software:

- 1. Support for web client.
- 2. Support for mobile client.

2.3 CLIENT WORKSTATIONS

A. Provisioning:

- 1. The workstation(s) shall be furnished by the Owner and shall meet the specifications defined by the SMS software manufacturer to meet or exceed the functionality and performance specifications of the system and integrations defined in this and related sections. Contractor shall furnish specifications to the Owner in writing as part of the submittals.

B. Hardware:

- 1. [Rack mount][Desktop][Laptop] configuration

2. Pentium 4 Dual Core CPU, 2.5 GHz or greater
3. 4 GB RAM
4. 100GB hard drive, 7200 RPM
5. Four (4) USB 2.0 ports, dual 10/100/1000 network interface card
6. Audio with amplified speakers with AC adapter.
7. [One (1)<Insert> 19" flat screen LCD monitor(s)]
8. [Dedicated 256 MB SVGA accelerated video card][NVIDIA graphics dual output board, PCI Express x 16 graphics bus, 512 MB DDR3 memory buffer, 1280 x 1024 resolution]
9. 16x DVD/CD RW drive

C. Operating System:

1. Windows 10 Professional

2.4 FIELD CONTROL HARDWARE

A. Interior Control Panels:

1. Control boards, power distribution and terminals shall be enclosed in a [NEMA 1][NEMA 12][NEMA 4X stainless steel] rated enclosure that is [pad-lockable][key lockable]. Contractor shall not furnish padlock. All enclosures that are part of this project shall be keyed alike. Contractor shall furnish and install a mechanically fastened tamper switch on the interior of the enclosure.
2. Control boards are allowed to be in an enclosure separate from the power supplies/power distribution. Should they be in separate enclosures, the interface wiring shall be in rigid metallic conduit, RMC, with Myers hubs at both ends of the conduit.
3. Control panels shall be rack mountable in an enclosure specifically for rack mounting. Control boards and power supplies shall be located in the enclosure. The enclosure shall have screw or compression terminals on the rear panel for connection of field devices.
4. Intra-enclosure wiring shall be dressed using tie wraps and/or covered plastic wire way. Hook-up wires for identical purposes shall have the same color insulation. For example, if one input pair utilizes green and white insulated conductors, all similar inputs shall use green and white insulated conductors. The same color scheme shall be followed for all access control panels that are part of this project.
5. Cabling from field devices such as readers, door position switches, request-to-exit devices and locking devices shall not be directly terminated to the control boards and power supplies. The field devices shall be terminated to terminals located on the left side, right side or both sides of the enclosure back panel. Intra-enclosure wiring shall be routed from the terminals to the control boards and power distribution. Quantity and functional sequence of the terminals shall be identical portal to portal.
6. All devices inside the enclosure, less cabling and batteries, shall be mechanically fastened to a removable solid or perforated metal back panel with either:
 - a. Metal or plastic standoffs
 - b. DIN rail
7. Hook and loop fasteners, double sided tape or adhesives are not allowed to attach devices to the back panel. Mounting devices to the interior of the door shall only be allowed when the following two (2) conditions are met:

- a. The access control hardware manufacturer offers prefabricated enclosures with devices mounted to the interior of the door.
 - b. Only the same devices that the access control manufacturer mounts to the interior of the door are allowed to be mounted in a different enclosure, and those devices shall be mounted in an identical manner.
8. 120V 20A input power shall be hard wired to a circuit breaker disconnect and to one duplex receptacle on the interior of the enclosure. Should devices in the enclosures require plug-in transformers/power supplies, the receptacle shall be utilized. One (1) power strip with integrated circuit breaker shall be located in the bottom of the enclosure as needed.
9. Power to the locking devices shall be provided by a power distribution board with no fewer than four (4) outputs. Each lock shall be individually protected. The power distribution board shall:
- a. Provide protection with fuses or positive temperature coefficient (PTC) devices.
 - b. Provide control so that each output is individually selectable as latching or non-latching with fire alarm activation.
 - c. Provide control so that each output shall have Fail Safe and Fail Secure terminals.
 - d. Provide a fire alarm input with associated trigger LED.
 - e. Provide an individual LED per output to indicate when an input has been triggered and the associated output has been activated.
 - f. Accept a dry, closed contact input to activate the individual lock outputs.
 - g. Provide a dry, Form C relay that energizes on activation of the fire alarm input. This output may then be used as a fire alarm input to other power distribution boards in the same or a different enclosure, or may provide input to another device such as a multi-pole relay.
10. A minimum of four (4) 12V 7 AH rechargeable, sealed, lead acid batteries shall be located in the bottom of the enclosure. Two of the batteries shall be connected in series for 24V devices, and two batteries shall be connected in parallel for 12V devices. [Contractor shall provide additional batteries as needed to power all devices for a minimum of <Insert> hours.] Connections to the batteries shall be made with appropriate terminals crimped on the connecting conductors. Batteries shall be clearly labeled in a permanent manner with the date of installation.
11. Power to control boards, readers and auxiliary devices such as request-to-exit motion detectors shall be provided by a power distribution board with no fewer than four (4) outputs. All devices powered by the same voltage at an individual portal shall be protected by the same fuse or PTC unless current requirements dictate otherwise. Individual fuses or PTCs may protect more than one control board.
12. All access control panels, when populated with control boards and power supplies, shall have the following capacities:
- a. Control of a minimum of two (2) portals.
 - b. Spare capacity of a minimum of one (1) access control portal, two (2) auxiliary inputs and two (2) auxiliary outputs greater than the requirements of the project at the time of system specification.
 - c. Five (5) spare fuses of each type used, to be in their original packaging, to be located in each power supply enclosure.

- d. 50% spare current capacity on all power supplies located in unconditioned spaces and 40% spare capacity for those in conditioned spaces. Lower spare capacities are allowable based on prior approval of Contractor-provided power calculations.
 13. Locations where enclosures may be mounted are shown on the plans. Final location, with approval of Owner's representative, shall be selected by Contractor based on distribution of controlled portals and devices.
 14. At time of Substantial Completion, Contractor shall furnish a schematic diagram of intra-enclosure wiring and a complete bill of materials for the enclosures and the devices located within. This documentation shall include a schedule of fuses and the device(s) that each fuse protects. This documentation shall be placed by Contractor in a Contractor-furnished print pocket located on the inside of the enclosure door.
- B. Intelligent System Controllers (ISC):
1. The controller shall communicate with the host via an on board 10/100 Base T Ethernet port.
 2. The controllers shall be a distributed architecture with full peer-to-peer networking capability. Parent/Child controller configurations are not acceptable. All controllers in the system shall be capable of operating in a standalone mode if communication is lost with the server or main controller. In no case shall a controller depend on communication with an upstream controller for proper standalone operation.
 3. The communications bus shall be supervised for wiring integrity. If a communication failure is detected, the system shall report the loss. All controllers unable to receive communication shall operate as standalone devices including grant/deny decisions, complete with event buffers. All events shall be uploaded to the server upon restoration of communications.
 4. Controllers shall be AES 128-bit symmetrical block encryption devices conforming to FIPS-197.
 5. Controllers shall support SHA-1 authentication security.
 6. The controllers shall utilize flash memory or similar technology, allowing program updates to be downloaded from the server. Program storage shall be in ROM.
 7. The controllers shall have the capacity for 15,000 cardholders and 45,000 transactions. All access decisions involving these cardholders shall be made at the lowest controller level without communication to the server.
 8. 32-bit microprocessor controlled.
 9. Handle all non-host related access control monitoring and decision making.
 10. LED indicators for power, fault and communications.
 11. Provide for local and global input/output linking:
 - a. The SMS shall support a global linkage feature whereby any input/output/event shall be linked to any other input/output/event in the SMS. Input/output linkages shall be able to span across intelligent system controllers.
 - b. System administrators shall be able to create global input/output function lists, each consisting of a sequence of actions to be performed, such as changing card reader modes, activating outputs, and opening or closing anti-pass back areas. Each function list may include up to six actions.
 12. Reporting of transactions and status information to the server.

13. Interface with standard reader technologies without special interface hardware, additional logic panels or other integrators. Supported technologies shall include:
 - a. 13.56 MHz Contactless Smart with or without biometrics or keypad
- C. Reader Interface Module (RIM):
1. Reader interface modules are not shown on the plans. Refer to the installation section of this specification for allowable equipment mounting locations. It is the responsibility of the Contractor to determine the number and configuration of reader interface modules required based on the inherent characteristics of each product line and the requirements and restrictions described in this document.
 2. RIM shall interface with and accept data from TTL, Wiegand and RS-485 type readers and door hardware.
 3. RIM shall provide a minimum of three (3) inputs per portal for portal position, request to exit and auxiliary input.
 4. RIM shall provide a minimum of two (2) outputs per portal for locking device and auxiliary output. Each output shall be Form C and shall be rated at 3A at 28VDC.
- D. Input Control Module (ICM):
1. The input control module shall provide supervised and non-supervised alarm input zones and monitor/report line fault conditions, alarm conditions, power faults and tampers.
 2. Input control modules are not shown on the plans. Refer to the installation section of this specification for allowable equipment mounting locations. It is the responsibility of the Contractor to determine the number and configuration of input control modules required, based on the inherent characteristics of each product line and the requirements and restrictions described in this document.
 3. UL 294 and 1076 listed.
 4. Each input configurable for normally open or normally closed.
 5. Each input configurable for timing.
 6. Each input configurable for end of line resistance.
 7. Status LEDs for communication to the host, heartbeat and input status.
 8. Communications line supervision.
 9. AES 128 bit encryption.
 10. 2-wire RS485 communications.
 11. No fewer than eight (8) inputs per board/control module.
 12. Assignment of unit addresses and communications speed.
 13. Alarm Masking: The ability to mask the alarm input on a time zone basis.
 14. Activate Output: The ability for any input to activate any output.
 15. Configuration of Debounce Time: The ability to control the amount of time that an input state change must remain consistent in order for it to be considered a real change of state.
 16. Noise rejection filtering to prevent false alarms.
 17. Global Linkage: The ability to link outputs with inputs that are attached to any ICM/output control module (OCM).
 18. Checkpoint: The ability to configure an input as a designated stop on one or more guard tours.
 19. Entry/Exit Delay: The ability to set up entry/exit delays for inputs that are attached to any ICM. This shall include:

- a. Non-Latched Entry: When an input activates, the alarm will not be reported until the entry delay expires. If the input is still active when the entry delay expires, the alarm will be reported. If the input is not active when the entry delay expires, then the alarm will not report.
- b. Latched Entry: When an input activates, the alarm will not be reported until the entry delay expires. If the input is still active when the entry delay expires and the alarm has not been masked, the alarm will be reported. If the input has been masked when the entry delay expires, then the alarm will not report.
- c. Exit Delay: When an input activates, the alarm will not be reported (operates as if masked) until the exit delay expires. If the input is still active when the exit delay expires, the alarm will be reported. If the input is not active when the exit delay expires, the alarm will not be reported.

E. Output Control Module (OCM) and Functionality:

1. Output control modules are not shown on the plans. Refer to the installation section of this specification for allowable equipment mounting locations. It is the responsibility of the Contractor to determine the number and configuration of output control modules required, based on the inherent characteristics of each product line and the requirements and restrictions described in this document.
2. The output control module(s) shall provide Form C relay contacts for load switching, rated at 3A at 28VDC.
3. Each relay shall support "On" "Off" and "Pulse."
4. Outputs can be pulsed from 0.1 seconds to 24 hours.
5. Status LEDs for communication to the host, heartbeat and relay status.
6. 2-wire RS485 communications.
7. No fewer than eight (8) outputs per board/control module.
8. Communications line supervision.

2.5 APPLICATION SOFTWARE

A. General Performance:

1. The application software, in conjunction with the associated hardware, shall have the following features, functionality and capabilities. The functions that are to be implemented shall be determined in the planning conference between Contractor and Owner referenced in Part 3 of this section.
2. All Users:
 - a. All users shall be capable of being authenticated against Active Directory using LDAP before being granted system access. Should the Owner not use Active Directory, the system shall provide a built-in login and credential management tool to permit rules-based access rights on a per-user basis.
 - b. The access rights shall be selectable on a per-user basis. In addition, user groups shall be capable of being assigned whereby each user group has a common set of access rights. Users shall be capable of being assigned to these user groups by the system administrator.
3. Operators:

- a. The SMS operator interface shall be standard Windows style graphical interface allowing point and click access to features such as drop-down menus, radio buttons, check boxes, list boxes and other standard Windows components.
 - b. On-line Context Sensitive Help: The SMS shall provide on-line context sensitive help files to guide system administrators and system operators in the configuration and operation of the SMS. The help menu shall be available from any window in the SMS by pressing one function key or clicking on the "HELP" icon/selection in the toolbar. Help windows shall be context sensitive so operators and system administrators can move from form to form without leaving the help window. The SMS shall come with complete on-line documentation on CD or the ability to offload the documentation to removable media.
 - c. Operator Groups: A minimum of 32 operator groups, allowing specific system module privileges to be accessed with each module being granted specific views, edit and execute privileges.
 - d. Operator Levels: System access shall require a valid operator name and password, governing a specific operator's level of access to each menu item.
 - e. The SMS shall allow a system operator to login over another system operator who is already logged into the same client workstation without the need to reboot the system. This process shall log the first system operator off alarm monitoring and log the new system operator on, changing any permission necessary for that system operator.
4. Logs, Status, Maintenance, Diagnostics:
- a. Historical Log: The system shall allow event history to be written to the hard disk in an archive format. At a minimum, the system shall support 500,000 transactions. Warning messages shall be generated at a user defined level of capacity. The system shall have the ability to offload the archive files to removable media automatically or manually.
 - b. System Status: The system shall query the status of any or all of the system's access control points, inputs and outputs.
 - c. System Maintenance/Diagnostics: The system shall provide for remote diagnostic capabilities. In addition, online diagnostics and communications maintenance shall be able to be activated from the operator interface.
5. Administrator:
- a. The SMS shall provide system administrators with the ability to segment their access control SMS field hardware devices into various zones or areas where alarm monitoring client workstations will monitor. These zones shall be assigned an alphanumeric name using up to a minimum of 64 characters.
 - b. The SMS shall allow other devices such as card readers, input and output modules and intelligent system controllers to be automatically part of the monitoring zone when an intelligent system controller is selected, and it shall allow the system administrator to define which devices such as card readers, etc. belong to that monitor zone.
 - c. Updating of monitor zones shall take place in real time and without requiring operators to re-login.
6. General:

- a. Elevator control support for the number of floors and cabs shown on the drawings.
- b. The SMS software shall be written to Microsoft's published standards for user interface design, secure coding practices and database implementation guidelines such as Microsoft Open Database Connectivity (ODBC) interface.
- c. All tasks shall be accessible from any compatible client workstation on the network using one or all of the following:
 - 1) Traditional client/server architecture.
 - 2) N-Tier architecture where the SMS shall support the expansion of the system architecture and allow for end-user deployment. The SMS shall allow, but not require, the separation of the database, application server, web server and client interface. The system shall require that all connections to the database be performed through a trusted link from the client or internet browser interface.
 - 3) Centralized publishing of applications using Windows Terminal Server and Citrix through any compatible internet browser application and/or by mobile computer including tablet PC.
- d. The SMS shall use an open architecture where all data must reside on a single database and must be accessible in real time to every SMS workstation or web-based client connected to the network. The system database shall be used to create and maintain the cardholder database. A screen designer module shall allow the creation and editing of custom database tables and data entry screens.
- e. The SMS shall be able to connect to and interface bi-directionally with external data sources using all of the following methods:
 - 1) ASCII with support for XML-formatted text exchange of data activated both manually and automatically.
 - 2) ASCII with support for XML-formatted text exchange of data using a direct table interface activated both manually and automatically.
 - 3) Real time exchange of data via Active Directory/LDAP utilizing an API supported by the SMS manufacturer. The live exchange of data shall permit exposure of SMS events and transactions to other data sources in real time and allow for receipt of data into the SMS, permitting this data to be acted upon and trigger linked events in the SMS in real time.
- f. Security: Access privileges within the application software shall be permitted by use of a password protection system. The cardholder database shall have the following password security levels.
 - 1) A minimum of six (6) unique operator access levels
 - 2) Ability to view only the database fields
 - 3) Ability to restrict operator viewing to any of the individual database screens within a record
 - 4) Ability to restrict operator viewing to any of the database partitions
- g. Cardholder Configurations: The system shall have the capacity to support a minimum of 25,000 cardholder files. Each cardholder shall be capable of having up to five (5) access levels actively assigned to their account.

- b. In the event of a communication failure of the primary path, the ISC shall initiate a switchover to the secondary path. During this fail switchover period, the ISC shall periodically check to see if the primary path has been re-established and will automatically switch back upon a successful connection. Alarms shall be generated upon loss or restoration of communications.

10. Intelligent System Controller Remote Support:

- a. The SMS shall support remote operations to and from the intelligent system controller (ISC). The remote connection shall be either a constant connection or a scheduled connection. If the connection is constant, then every panel shall have its own connection at the host. If the connection is scheduled, then all panels using remote connections shall have the ability to share the same host connection(s).
- b. System administrators shall have the ability to define the remote connections available in the pool. For each connection, system administrators shall be able to define the connection type and the client workstation to which it is installed.
- c. Remote sessions shall occur under any of the user defined scenarios:
 - 1) On Demand Connection: A system operator shall have the ability to automatically initiate a remote session to an ISC via the alarm monitoring module.
 - 2) Scheduled Connection: System administrators shall have the ability to configure the SMS so that the ISC remotes into the SMS at pre-determined times through use of time zones.
 - 3) Critical Alarm Activated: System administrators shall have the ability to configure the SMS so that the ISC initiates a remote session with the SMS when a critical alarm is activated in the field.
 - 4) Buffer Threshold: System administrators shall have the ability to configure the SMS so that the ISC initiates a remote session with the SMS when a pre-determined number of events are stored in the ISC memory buffer.

2.6 CREDENTIALS AND BADGING

A. Credentials:

- 1. [Multi-Technology][Contactless Smart] Cards: 13.56 MHz radio frequency identification electronics, passive design. Card shall meet ISO 15693 and ISO 14443B2 standards.
 - a. Maximum Dimensions: CR 79: 3.313" x 2.063" x 0.04", CR 80: 3.375" x 2.125" x 0.04".
 - b. Construction to be of PVC or polyester laminate[with a high coercivity magnetic stripe rated 4000 Oersted.]
 - c. Each card shall contain a unique serial number.
 - d. Cards shall contain options for various memory capacities of 2k, 16k or 32k with a fixed number of application areas or areas which are sized by dynamic allocation.
 - e. Each application area shall contain a unique authentication key. The card and reader shall require matching keys in order to function together. All RF communication between card and reader shall be encrypted using a secure algorithm.
 - f. The card shall be protected with DES or 3DES encryption algorithms.

- g. The cards shall be provided with custom keys uniquely matched to individual sites/customers to allow a non-interchangeable, high level of security through the use of formatting programs such as HID iClass Elite or Corporate 1000.
- h. Cards shall be encoded with bit lengths that are compatible with all other components of the SMS.
- i. Application areas shall be reserved for cashless vending applications.
- j. Cards shall support programming and updating of custom applications after issue.
- k. Cards shall be capable of having a photo and/or other graphical images printed directly on the surface of the card.
- l. Provide optional slot punch-outs on the short and long edge of the card.
- m. Provide multi-technology cards. Cards shall be individually numbered with sequential matching of internal and external numbers.
- n. Cards shall be provided with a lifetime warranty; 15 months for the magnetic stripe.

2.7 PORTAL DEVICES

A. Credential Readers:

- 1. Manufacturers:
 - a. HID Multiclass SE
- 2. Multi-Technology:
 - a. Compatible with 125 kHz proximity, 13.56 MHz Contactless Smart card, MIFARE, DESFire EV1.
- 3. Card readers manufactured specifically for non-access control applications shall not be acceptable.
- 4. FIPS 201 compliant.
- 5. Provide compatibility with most access control systems by providing card data outputs in Wiegand and Clock/Data.
- 6. Allow the firmware to be updated in the field without the need to remove the reader from the wall.
- 7. Secure mounting methods using tamper resistant screws.
- 8. An audio beeper that provides various tones to signify access granted, access denied, power up and diagnostics.
- 9. Tri-color LED or three (3) LEDs for visual notification of various conditions.
- 10. ISO1443A, 1443B and 15693 compliant.
- 11. The ability to transmit an alarm from an integrated tamper switch.
- 12. Support dual authentication of identity through the combined use of access badge and personal identification number (PIN) on an integrated 12 key keypad.
- 13. PBT polymer or UL94 polycarbonate.
- 14. Read Range:
 - a. Using 125 kHz cards or 13.56 MHz Contactless Smart cards, minimum operational read range shall not be less than one (1) inch after the readers have been installed in their permanent locations.

15. Operational voltage of 5-16 VDC, with operating temperature range of -31° F to 150° F, and rated for outdoor use with a minimum rating of IP55.
 16. Readers and credentials shall be compatible with each other and shall be from the same manufacturer.
 17. Available in sizes to be mounted to a standard single gang box or to a mullion. Maximum sizes:
 - a. Single gang box mount, with or without keypad: 5.1" x 3.1" x 1.1"
 - b. Mullion mount: 6.0" x 1.9" x 0.9"
 18. Lifetime warranty against defects in material and workmanship.
- B. Request-To-Exit Motion Detector:
1. Manufacturers:
 - a. Bosch DS 160 Series
- C. Request-To-Exit Button:
1. Manufacturers:
 - a. Dyalock 6290 Series
- D. Door Position Switch:
1. Manufacturers:
 - a. GE
 - b. GRI
 - c. Honeywell
 2. Interior or Perimeter Door:
 - a. One (1) inch or 0.75 (3/4) inch diameter, recessed
 - b. 0.75" to 1.25" (3/4" to 1-1/4") gap for wood door
 - c. Maximum 0.375" to 0.625" (3/8" to 5/8") gap for steel door
 - d. Basis of Design: UTC/GE/Sentrol 1076D
- E. Cable:
1. Composite cable is allowed, although sufficient conductors may not be available in composite cables for all portal configurations. Contractor shall be responsible for additional required cables beyond one composite cable to each portal to meet functional requirements of the system.
 - a. Reader: 22 AWG, 3 pair, stranded, overall shield. Shield shall be grounded at control panel end only.
 - b. Request to Exit Motion Detector: 22 AWG, 4 conductor, stranded.
 - c. Door Position Switch: 22 AWG, 2 conductor, stranded.

- d. Request to Exit Button: 18 AWG, 4 conductor, stranded.
- e. Lock: Minimum 18 AWG, 4 conductor, stranded.
 - 1) Lock may require heavier gauge cable depending on door hardware solution power requirements. Contractor shall coordinate with door hardware provider for higher current devices and shall adjust the gauge of the lock cable accordingly.
- f. Auxiliary Devices: Refer to plans for requirements.

F. Locks and Door Hardware:

- 1. Electric/electronic locks shall be furnished and installed by the door hardware provider.
- 2. Access Control Contractor shall interface with and terminate cables to locks.
- 3. Access Control Contractor shall coordinate with door hardware provider for specified sequences of operation at the various portals.
- 4. Electrified cylindrical and electrified mortise locks shall have an integrated request-to-exit device.
- 5. Electric strikes shall have an integrated latch bolt monitor, and the dead latch shall be seated properly so that the strike cannot be defeated by manipulation.
- 6. Magnetic locks shall have a magnetic bond sensor.
- 7. Refer to architectural specifications and/or the architectural door schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with the manufacturer's instructions and recommendations for installation of all products.
- B. Provide all system wiring between all components as shown on the project drawings or as directed by the manufacturer, whichever is the more stringent requirement.
- C. Network controllers shall be installed centralized in the nearest telecommunications room(s). Mount controllers to the structural walls in a location coordinated with other utilities. Coordinate exact location with Architect/Engineer prior to installation. Provide dedicated +120 VAC emergency power circuit to the controllers using #12 AWG wiring from the nearest emergency electrical power distribution panel board.
- D. Provide wiring and connection to all electrified locking hardware devices. Complete programming and testing of all electrified locking hardware devices.
- E. Install all credential readers in accordance with manufacturer's instructions where shown on floor plans, in accordance with the Americans with Disabilities Act (ADA) requirements. Provide wiring and connection to all credential readers. Complete programming, adjustment, and testing of all credential readers.

- F. Provide wiring and connection to all hardware request-to-exit devices that are integral to electrified door hardware. Provide wiring and connection to all request-to-exit motion detectors. Complete programming and testing of all integrated request-to-exit devices. Where possible, avoid false activation by persons passing by but not exiting.
- G. Install all request-to-exit motion detectors in accordance with manufacturer's instructions directly above the door frame, centered on the door opening. Adjust sensitivity to permit operation on motion of persons within 2'-0" of door. Avoid false activation by persons passing by where possible.
- H. Install all request-to-exit pushbuttons in accordance with manufacturer's instructions where shown on floor plans, in accordance with the Americans with Disabilities Act (ADA) requirements. Provide wiring and connection to all request-to-exit pushbuttons. Complete programming, adjustment and testing of all request-to-exit pushbuttons.
- I. Install all door alarm contacts in accordance with manufacturer's instructions either recessed in the door header or surface mounted as required. Provide wiring and connection to door alarm contact devices. Complete programming, adjustment and testing of all door alarm contacts.
- J. Install all duress switches in accordance with manufacturer's instructions, surface mounted under counter in locations shown on plans. Verify exact mounting location with Owner prior to cable rough-in or installation. For hard wired devices, provide wiring and connection to duress switch devices. For wireless duress switch devices, mount receivers in accessible locations. Complete programming, adjustment and testing of all duress switch devices. Wireless testing shall include signal reception when transmitter is in all sections of the area in which it will be used in normal operations.
- K. Install, wire, configure, adjust, program and test all access control system servers, workstations, badgeing workstations and other user interfaces.
- L. Install, wire, configure, adjust, program, and test all specified interfaces and integrations between access control and other systems. Contractor shall provide all cabling, wiring, terminations, components, devices, accessories, hardware, software and other material and accessories necessary to complete all specified interfaces and integrations and make them fully operational.
- M. All low voltage access control cabling shall be routed and supported completely separate from any and all other telecommunications or other low voltage system cabling.
- N. Electronic access control system cabling shall not be spliced.
- O. Flexible conduit is not allowed except with prior approval. Refer to Section 26 0533 for conduit requirements. Refer to Section 27 0528 for cable hanger and support requirements.
- P. Each cable shall be appropriately identified, as defined on the record documents, at each end's termination point using pressure sensitive label strips.
- Q. The conductor color code used in terminating system cabling at system devices shall remain consistent from device to device for each unique device type throughout the project.

- R. Install and tighten all connectors in accordance with manufacturer's instructions using the appropriately designed tools recommended by the manufacturer for that purpose. Do not strip or damage connectors, terminals, or equipment by over tightening termination fasteners.
- S. Grounding and Bonding Requirements:
 - 1. Provide a minimum of 6AWG bonding conductor from each electronic access control system control panel, power supply and surge suppression device to the nearest telecommunications grounding busbar. Actual bonding conductor size is determined by its length; refer to Section 27 0526 for grounding and bonding conductor sizing criteria.
- T. Coordinate installation of all devices with other trades and utilities in the vicinity.
- U. Cabling shall be plenum rated when installed outside conduit in plenum ceilings.

3.2 FIELD QUALITY CONTROL

- A. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product that meets the requirements of the specifications as supplied and warranted by the system vendor. If the product or assembly is not available from the system vendor, provide product or assembly as recommended by the system vendor.
- B. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the contract documents.
- C. Furnish products listed and classified by Underwriters Laboratories, Inc. (UL) as suitable for purpose specified and indicated.

3.3 MANUFACTURER AND INTEGRATOR COMBINED FIELD SERVICES

- A. Installation shall be performed by a factory-trained and certified Contractor.
- B. The Contractor shall provide a comprehensive, site-specific customer planning guide for the system. The Contractor shall conduct conference(s) with the Owner prior to any installation to discuss the programming and configuration options of the system and the planning guide.
- C. The Contractor shall include labor for all planning and all programming activities required to implement the Owner's access policies for each system point and each operator and administrator. Any software programmable access policy, within the bounds of the hardware specified, shall be included.
- D. It shall be the responsibility of the Contractor to provide a complete, functional system as described by the design documents. These responsibilities include:
 - 1. Complete hardware setup, installation, wiring and software configuration of the system server, all workstations and all peripheral hardware.
 - 2. Complete programming of all operator software in accordance with the Owner's access policies determined by the planning guide conference(s).
 - 3. Manual data entry of cardholders based on a printed roster provided by the Owner.

4. Configuration of the network software for operation of the system. Templates shall be established representative of all user access right levels.
5. Programming of all cardholder database screens including cardholder information screens, report templates, queries, etc. Encoding of proximity cards shall be included.
6. Programming of all custom graphic GUI screens including devices.
7. Complete system diagnostic verification.

- E. The SMS Installation Contractor shall be present at meetings to coordinate all door hardware requirements with the door hardware vendor.

3.4 SYSTEM DOCUMENTATION

- A. Complete documentation shall be provided for the system. The documentation shall describe:

1. All operational parameters of the system
2. Complete documentation of programming and access policies
3. Complete operating instructions for all hardware and software

- B. The following sections shall be provided in the system documentation:

1. System Administrator Manual: Provides an overview and a step-by-step guide and instructions detailing all system administrator responsibilities and functions.
2. User Manual: A step-by-step guide and instructions detailing all system user functions.
3. Alarm Monitoring Manual: A step-by-step guide and instructions detailing all alarm monitoring system functions and responsibilities.
4. Technical Maintenance Manual: A comprehensive document providing all maintenance actions, system testing schedules, troubleshooting flowcharts, functional system layout, wiring diagrams, block diagrams and schematic diagrams.
5. Refer to Part 1 for details.

3.5 SYSTEM TRAINING

- A. All labor and materials required for on-site system training by a certified representative of the system manufacturer shall be provided. Training shall be conducted at the project site using the project equipment.

- B. Coordinate training days and times with Owner.

- C. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.

- D. At a minimum, the following training shall be conducted:

1. System Administrators: A course detailing the system functions, configurations and operations. Provide training on all aspects of the system including data import/export, report, cardholder management, system workstation and server configuration and maintenance, software and hardware configuration and peripheral hardware operation.

2. Operators: A course detailing the operational features of all aspects of the user interface. Topics shall include alarm monitoring functions, reports, error handling, alarm handling, output relay control, operation of integrated systems interface, and general overview of the report hardware.
3. GUI Editing: Conduct detailed training on using the GUI editing software. Topics shall include the editing of existing graphical maps and the creation of new graphical maps.

E. Minimum on-site training times shall be:

1. System Administrators: Eight (8) hours.
2. Operators: Eight (8) hours.
3. GUI Editing: Eight (8) hours.
4. Integrations : Eight (8) hours.
5. Badging System: Eight (8) hours.
6. Four (4) additional hours of training each quarter for the 12-month period of the project warranty shall be provided. A minimum of half of this additional training shall be on site; the remainder may be support by telephone or email. Contractor shall document this training, including dates performed, trainer and Owner representative(s) present. Each phone call or email shall be documented as a minimum of 15 minutes duration.
7. Operators and administrators are present 24 hours a day, 7 days a week. Contractor shall coordinate with Owner to provide training for all appropriate personnel, which may require Contractor to be present on site during non-business hours. Therefore, the hours in any or all categories defined above may be divided among the various shifts.

3.6 SYSTEM ACCEPTANCE

- A. The SMS vendor shall submit for review a formal acceptance and system checkout program. The system checkout procedures shall include all system components, software and functionality. The Contractor shall perform the tests and document all results under the supervision of the manufacturer's systems engineer.
- B. All operational scenarios, as defined by the customer planning guide, shall be tested to simulate the actual use of the system in the normal operating environment. The successful completion of these operational scenarios shall be documented.
- C. The system shall not be accepted until all requirements of system documentation and training have been completed.

END OF SECTION

SECTION 28 2300 - VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Video Printer.
- B. Equipment Racks.

1.2 RELATED WORK

- A. Section 26 0533 - Conduit and Boxes
- B. Section 26 0513 - Wire and Cable
- C. Section 27 1500 - Horizontal Cabling Requirements
- D. Section 28 0500 - Basic Electronic Safety and Security System Requirements
- E. Section 28 3100 - Fire Detection and Alarm Systems
- F. Section 28 1300 - Electronic Access Control

1.3 QUALITY ASSURANCE

- A. NVMS Software Developer (Manufacturer): The NVMS system shall be a single-source manufacturer such that the single manufacturer develops, supports, and warrants the NVMS software solution. The manufacturer shall have three (3) years documented experience.
 - 1. The software developer shall be, at a minimum, a Microsoft Gold Certified Integrator and Partner for systems that reside in a Microsoft environment.
 - 2. The software developer shall be an active ONVIF member with current available product recognized by ONVIF as a Conformant Product.
- B. Integrator/Installer (Contractor): The Contractor must be a NVMS-certified installation, service, and support company specializing in the selected manufacturer's product, with demonstrated prior experience with the selected manufacturer's system installation and programming.
 - 1. The installer shall have in-house a Microsoft MCSE or equivalent technician for the purposes of server deployment, software configuration, and system integration.
 - 2. The integrator must have local service representatives within 100 miles of the project site.

1.4 REFERENCES

- A. NFPA 70 - National Electrical Code
- B. Electronic Industries Association (EIA) Video Surveillance Equipment Standards

- C. UL 2044 - Standard for Commercial Closed Circuit Television Equipment
- D. UL 3044 - Standard for Safety for Surveillance Closed Circuit Television Equipment

1.5 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 28 0500.
- B. Product Data Submittal: Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:
 - 1. Compliance with each requirement of these documents.
 - 2. All component options and accessories specific to this project.
 - 3. Electrical power consumption rating and voltage.
 - 4. Heat generation for all power consuming devices.
 - 5. All required wiring shall be identified.
 - 6. Number of IP addresses that will be required from the Owner's Information Systems Department.
 - 7. Statement of Acceptability of Designed Server:
 - a. If the Contractor agrees that the server(s) designed and described herein is acceptable for the chosen manufacturer's solution and meets the demand of the application, this shall be stated in writing and submitted as part of the shop drawing submittal.
 - b. If the Contractor does not agree that the server(s) designed and described herein is acceptable for the chosen manufacturer's solution, Contractor shall itemize the quantity, technical specifications, and capacities of the servers required to support the functionality and device quantities required by the project drawings. Indicate the capacity utilization factor for each server.
 - c. Contractor's bid shall include any required changes in server(s) capacity.
 - 8. Calculation for storage required using the criteria contained in the project drawings.
 - 9. Calculation for required network bandwidth, including any latency restrictions.
 - 10. Provide annual cost and all terms and conditions for the NVMS Software Maintenance Agreement. Include all additional costs and terms and conditions for any Annual Service Contracts provided by the Contractor for all services that are not included in the Software Maintenance Agreement.
- C. System Drawings: Project-specific system CAD drawings shall be provided as follows:
 - 1. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (e.g., multiple identical cameras), the diagram may show one device and refer to the others as "typical" of the device shown.
- D. Sample format of site specific programming guides to be used for system planning/programming conference with Owner.
- E. Meeting agenda for planning/programming conference required in Part 3 of this specification.

- F. Submit detailed description of Owner training to be conducted at project end, including specific training time.
- G. Quality Assurance:
 - 1. Provide materials documenting experience requirements of the manufacturer and installing contractor.
 - 2. Provide system checkout test procedure to be performed at acceptance. Test procedures shall include all external alarm events.
- H. Coordination Drawings:
 - 1. Include all ceiling-mounted devices in composite electronic coordination files. Refer to Section 28 0500 for coordination drawing requirements.

1.6 SYSTEM DESCRIPTION

- A. This specification section describes the furnishing, installation, commissioning and programming of a complete, turnkey, closed circuit television system.
- B. Performance Statement: This specification section and the accompanying project drawings are performance based, describing the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment constraints described and the performance required of the system as presented in these documents, the vendor and the Contractor are solely responsible for determining all wiring, programming and miscellaneous equipment required for a complete and operational system.
- C. Refer to the project drawings for model numbers for the Basis of Design for all equipment.

1.7 OWNER-SUPPLIED MATERIALS

- A. <Insert>

1.8 LICENSING REQUIREMENTS

- A. All licenses required for system operation shall be included in the Contractor's bid. Licenses shall include, but not be limited to, server and workstation software, cameras, encoders/decoders, and any other licensing that is required by the manufacturer for operation of any system component.
 - 1. Camera licenses shall be provided for all cameras listed on the Camera Schedule whether cameras are new or existing.
 - 2. The system shall be provided with installed software capacity to accommodate a minimum quantity of 30 < cameras. The licensing for all <Insert> cameras shall **NOT** be included in the Contractor's bid. Licensing shall only be included for the quantity of cameras shown on the Camera Schedule. However, the system's ability to support up to a total capacity of 50 cameras shall **ONLY** require future payment of additional per-unit camera licensing fees by the Owner. In no case shall the Owner be required to upgrade the software provided in the Contractor's bid to achieve support for a total of 50 cameras, including the payment of any software upgrade fees, installing a different software version, etc.

3. If the manufacturer requires the purchase of a block of licenses (instead of selling a single license for a single device) the Contractor's bid shall include the appropriate block of licenses that accommodates all device quantities described by the project drawings, plus 10 additional devices for future growth.
4. Camera licensing that is restricted to a particular device MAC address or in any way is only valid for a particular manufacturer or model number is not acceptable. Camera licenses shall be issued such that the Owner can replace a camera with another camera brand and/or model number and transfer the license from the old camera to the new camera at no additional cost at any future time. This license transfer procedure shall be capable of being performed by the Owner and shall not require the services of an integrator.
 - a. Exception: When a camera license is issued as a no-cost license in the limited condition that the NVMS manufacturer and the camera manufacturer are the same company, it is permissible to charge a future license fee to the Owner if the Owner elects to replace the NVMS manufacturer-branded camera with a third-party manufacturer's camera.

1.9 PROJECT RECORD DOCUMENTS

- A. Submit documents under the provisions of Section 28 0500.
- B. Provide final system block diagram showing any deviations from shop drawing submittal.
- C. Provide statement that system checkout test, as outlined in shop drawing submittal, is complete and satisfactory.
- D. Provide final camera type and camera requirements schedules documenting all changes made during construction.
- E. Warranty: Submit written warranty and complete all Owner registration forms.
- F. Complete all operation and maintenance manuals as described below.

1.10 OPERATION AND MAINTENANCE DATA

- A. Submit documents under the provisions of Section 28 0500.
- B. Manuals: Final copies of the manuals shall be delivered within 30 days after completing the installation test. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of the contractor responsible for the installation and maintenance of the system and the manufacturer for each piece of equipment for each system. The manuals shall have a table of contents and labeled sections. The final copies delivered after completion of the installation test shall include all modifications made during installation, checkout, and acceptance testing. The manuals shall consist of the following:
 1. Hardware Manual: The manual shall describe all equipment furnished including:
 - a. General description and specifications.
 - b. Installation and check out procedures.
 - c. System layout drawings and schematics.

- d. Alignment and calibration procedures.
2. Software Manual: The software manual shall describe the functions of all software and shall include all other information necessary to enable proper installation, testing, and operation. The manual shall include:
 - a. Definition of terms and functions.
 - b. System use and application software.
 - c. Graphical user interface use.
 - d. Reports generation.
3. Operator's Manual: The operator's manual shall fully explain all procedures and instructions for the operation of the system including:
 - a. Computers and peripherals.
 - b. System startup and shutdown procedures.
 - c. Use of system.
 - d. Recovery and restart procedures.
 - e. Use of report generator and generation of reports.
 - f. Data entry.
 - g. Operator commands.
 - h. Alarm messages.
 - i. System permissions functions and requirements.
4. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

1.11 WARRANTY

- A. Unless otherwise noted, provide warranty for one (1) year after Date of Substantial Completion for all materials and labor.
- B. Onsite Work During Warranty Period: This work shall be included in the Contractor's bid and performed during regular working hours, Monday through Friday.
 1. Inspections: Perform one minor inspection six-months after Substantial Completion and one major inspection prior to the expiration of the warranty.
 2. Minor Inspections: Inspections shall include:
 - a. Visual checks and operational tests of all equipment, field hardware, and electrical and mechanical controls.
 - b. Mechanical adjustments if required on any mechanical or electromechanical devices.
 - c. Install all available software updates, patches, or bug fixes available from the NVMS manufacturer.
 3. Major Inspections: Inspections shall include all work described under paragraph Minor Inspections and the following work:
 - a. Clean all equipment, including interior and exterior surfaces.

- b. Perform diagnostics on all equipment, including all system software diagnostics, and correct all diagnosed problems.
 - c. Adjust all camera alignments that have become out of alignment from their documented position at Substantial Completion.
 - d. Install all available software updates, patches, or bug fixes available from the NVMS manufacturer.
 - e. All warrantable system deficiencies during the Major Inspection shall be remedied under warranty at no cost to the Owner.
- C. Operation: Upon the performance of any scheduled adjustments or repairs, verify operation of the NVMS system.
- D. Emergency Service: The Owner will initiate service calls when the NVMS system is not functioning properly. Qualified personnel shall be available to provide service within the distance defined above. The Owner shall be furnished with telephone number(s) where service personnel can be reached 24/7/365.
- E. Records and Logs: Keep records and logs of each task completed under warranty. The log shall contain all initial settings upon Substantial Completion. Complete logs shall be kept and shall be available for review on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the NVMS system.
- F. Work Requests: Record each service call request on a service request form. The form shall include the model and serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing what must be done, the amount and nature of the materials used, the time and date work started, and the time and date of completion. Deliver a record of the work performed within five (5) days after work is accomplished.
- G. System Modifications: Make any recommendations for system modification in writing to the Owner. No system modifications shall be made without prior approval of the Owner. Any modifications made to the system shall be incorporated into the operations and maintenance manuals, and other documentation affected. To the fullest extent possible, the Owner shall be provided with electronic restorable versions of all configurations prior to the modifications being made.
- H. Software: Provide all software updates during the period of the warranty and verify operation in the system. These updates shall be accomplished in a timely manner, fully coordinated with NVMS system operators, shall include training for the new changes/features enabled, and shall be incorporated into the operations and maintenance manuals, and software documentation.
- I. Refer to the individual product sections for further warranty requirements of individual system components.
- 1.12 SOFTWARE MAINTENANCE AGREEMENT/ANNUAL SERVICE CONTRACT
- A. Provide annual cost and all terms and conditions for the Software Maintenance Agreement (SMA) provided by the NVMS manufacturer and/or the Contractor.

- B. The Owner will enter into a contract directly with the vendor. This specification is not a contract between the Owner and the vendor to perform these services. The cost and terms of the SMA *may* be used by the Owner for NVMS solution selection.

PART 2 - PRODUCTS

2.1 NETWORK VIDEO MANAGEMENT SYSTEM - GENERAL REQUIREMENTS

- A. The network video management system (NVMS) shall be an enterprise-class client/server based video security solution that provides management of digital video, audio and data across a TCP/IP network.
- B. Provide a turnkey solution that includes furnishing, installation, and configuration of a separate IP network, complete with all required network electronics, switches, and other hardware. The VMS shall utilize network switch ports provided by the Owner for all required IP connections. Provide the Owner with a complete list of all IP ports required.
- C. ONVIF Compliance:
 - 1. The NVMS system shall be ONVIF certified as an ONVIF Network Video Client.
 - 2. Cameras shall be ONVIF certified as an ONVIF Network Transmitter unless specifically noted as an exception to this requirement in the project drawings.
- D. The NVMS system shall be an "open system."
 - 1. To meet this requirement, the NVMS must directly support cameras from a minimum of three (3) readily available camera manufacturers.
 - 2. The three (3) camera manufacturers must have no corporate relationship to the NVMS manufacturer.
 - 3. "Directly support" shall be defined as plug-n-play using drivers that are commercially available at the time of bid that utilize the ONVIF specification as the means of integration.
 - 4. In addition to the requirement to support three (3) independent manufacturer's cameras, the NVMS may support an unlimited additional quantity of in-house or other proprietary cameras.
 - 5. The open system shall not require proprietary storage solutions. It shall support third party storage solutions, including:
 - a. Commercially available Direct Attached Storage (DAS) devices.
 - b. Network Attached Storage (NAS) devices.
 - c. Storage Area Networks (SAN) for *primary* or archival storage purposes. Primary support for SAN shall be defined as:
 - 1) The ability to directly record to SAN device without first recording to an NAS or DAS.
 - 2) The NVMS is provided with a user experience that makes the video recorded to the SAN transparent to the user. This shall be defined as:

- a) Full search, bookmarking, and other software features for finding, marking, locating, and identifying video are supported by the NVMS for video recorded to a SAN in an identical way to video that is recorded to an NAS or DAS.
 - b) No loading of the video from the SAN into the NVMS shall be required.
 - c) Full playback, windowing of camera video, archiving, and exporting is supported by the NVMS for video recorded to the SAN in an identical way as video recorded to an NAS or DAS.
6. The system must have a published API/SDK permitting third party integrations to the product without restrictions.
 7. The NVMS shall support active directory using LDAP protocol.
- E. The NVMS system shall consist of the following hardware/software components:
1. Software:
 - a. Server and client
 - b. Recording services, archival services, and storage management
 - c. Configuration tools
 2. System storage as specified on the project drawings.
 3. Cameras and related hardware as specified on the project drawings.
 4. Hardware: Servers, workstations, and miscellaneous hardware (keyboard, mouse, KVM) as specified on the projects drawings.
 5. Network electronics and related hardware and software as specified on the project drawings.
- F. Video from any camera on the system (on the LAN, WAN or Internet) shall be capable of being viewed from single or multiple workstations simultaneously at any time, limited only by network bandwidth.
- G. The NVMS shall support simultaneous displaying of live (30 fps) video of a minimum of 16 cameras while the video monitoring screen is configured in a 16-camera split configuration. In no case shall the frame rate of the camera be required to be restricted to less than 30 fps to display a 16-camera split view.
- H. Simultaneous display and recording of every camera shall be supported with independent user-adjustable frame rates that can be set differently for the display stream and the recording stream. These independent settings shall be unique per camera.
- I. The NVMS monitoring software shall support any combination of recorded and live video in any multiple camera split view, including viewing recorded video and live video from the same camera.
- J. The NVMS shall support continuous recording and event-based recording simultaneously. This shall be capable of being set on a per camera basis.
- K. Viewing of video (live and recorded) shall be possible from client software from any client hardware that is connected to the security LAN/WAN or Internet (through appropriate firewalls). In addition, system administration shall be permitted from remote client hardware.

2.2 NVMS MANUFACTURERS

A. Basis of Design:

1. Avigilon

2.3 NVMS SERVER REQUIREMENTS

- A. The NVMS shall operate on the Windows 2008 Server Operating System. The server software shall be a multi-tasking, multi-threading application system architecture designed specifically for the Windows environment.
- B. The server shall communicate on a TCP/IP based Ethernet LAN capable of utilizing 100/1000BaseT.
- C. The server shall be provided by the Owner.

2.4 NVMS SYSTEM DETAILED REQUIREMENTS

A. Software Security Requirements:

1. All users shall be capable of being authenticated against Active Directory using LDAP, before being granted system access. Should the Owner not use Active Directory, the NVMS shall provide a built-in login and credential management tool to permit rules-based access rights on a per-user basis.
2. The access rights shall be selectable on a per-user basis. In addition, user groups shall be capable of being assigned whereby each user group has a common set of access rights. Users shall be capable of being assigned to these user groups by the system administrator.
3. Access rights available for customization shall include:
 - a. Live Video Viewing:
 - 1) Use of PTZ controls.
 - 2) Start and stop of manual recording.
 - 3) Access to and exclusive from individual cameras and monitors.
 - 4) Access to system settings.
 - 5) Ability to define video blocking positions of PTZ cameras for certain users.
 - b. Viewing Recorded Video:
 - 1) Ability to export recorded video, including email.
 - 2) Access to system archiving and backup.
 - 3) Ability to watch recorded video from individual cameras.
 - 4) Ability to delete recorded video.
 - c. Camera Setup:
 - 1) Add or remove cameras from the system.
 - 2) Change camera settings including resolution and frame rate.

3) Change motion detection and other defined triggers.

d. General Settings:

- 1) Change client software settings.
- 2) Ability for user to configure or change custom viewing screen configurations.
- 3) Modify server settings.
- 4) Change recording or bandwidth settings.
- 5) Configure users.
- 6) Access and configure external messaging capabilities.
- 7) View, print, save and clear the system log.

B. Pan/Tilt/Zoom (PTZ) Control:

1. The NVMS shall support PTZ control from any client, including remote and mobile clients.
2. The following PTZ features shall be supported:
 - a. Priority Levels
 - b. Device Group Control
 - c. PTZ Override (Lockout)
 - d. Proportional PTZ Control
 - e. Preset Lock via video screen

C. Video Archiving:

1. The archiving feature shall be hardware independent, providing the ability to utilize commercial off-the-shelf mass storage devices as archived video destinations, including optical DVD, DAS, NAS, SAN, and other external storage drives.
2. The archiving software shall provide the ability to manage and store video information from multiple recorded video locations to a central location.
3. Each NVMS server shall have the ability to set its own unique archiving settings. Video shall automatically be archived based on user-defined "percentage full" settings. When the NVMS reaches the designated capacity threshold, video shall be automatically copied to the archive storage destination, and space on the source of the recorded video shall be released for overwrite by new video information using a first-in, first-out algorithm.
 - a. Exception: Video marked or tagged by the user or by automated alarm inputs shall be retained by the archiving process despite its location in the first-in, first-out timeline.
4. Regardless of the video's storage location (local or in the archive), the NVMS software shall automatically retrieve video associated with an event on demand by the user in response to a search, browse, or other retrieval action. The actual storage location of the video shall be transparent to the user.
 - a. Exception: Video archived to removable media (e.g., removable hard drives or optical DVD) shall require prompting to the user to insert the appropriate media.
5. Archiving shall be capable of being scheduled such that archiving will only run during certain hours defined by the Owner.

6. The NVMS solution shall be permitted to utilize advanced algorithms for managing onboard storage such as reducing the frame rate of recorded video for the oldest video as an alternative to completely removing the video using a first-in, first-out algorithm. If this option exists in the NVMS software, it must have the following features:
 - a. Ability of the Owner to completely disable the feature.
 - b. Ability to set a minimum frame rate that the system will not exceed.
 - c. Ability to set the feature on a per-camera basis.
- D. Video Viewing Layouts:
1. The NVMS shall support the ability to save the list of camera views currently being displayed, along with the currently selected template, with a user-defined name to be loaded as needed by the system operator.
 2. System operators shall have the ability to define multiple viewing templates that can be recalled and configured on an as-needed basis.
 3. This feature shall be subject to the access rights provided by the system administrator through their login credential.
- E. Still Image Capture/Save:
1. During playback or monitoring of video, the system shall have the ability to create and save a still picture. This operation shall not affect any other operation and shall not alter the recorded video. The file format shall be an industry standard format (JPEG, TIFF) allowing for file transfer via e-mail, printing, or file transfer to other media.
 2. This feature shall be subject to the access rights provided by the system administrator through their login credential.
- F. Export Video Clip to File:
1. The NVMS shall have to ability to save and export recorded video to a file (MPEG, AVI) for sharing and reviewing video clips. The start and end times for each video segment shall be user defined. The exported video clip shall be viewable via a standard Windows media player.
 2. This feature shall be subject to the access rights provided by the system administrator through their login credential.
- G. Automated Motion Video Searching:
1. The system shall support advanced automated motion video searching against pre-recorded video. The automated motion video search shall analyze frames in a video segment to detect motion activity from image to image. It shall display thumbnail images of the frames with activity, complete with a histogram depicting the relative amount of activity within each frame.
 2. The search shall be defined by selecting a specific camera and a specific time period in which the suspected activity took place. All motion events associated with that camera and time period shall be displayed in either a trace or thumbnail format for review.
- H. Video System Analytics (VSA):

1. The result of a trigger of an VSA shall be user definable and shall include:
 - a. Marking video.
 - b. Adjusting recording characteristics including frame rate and resolution.
 - c. Activating changes in the monitoring of cameras, including showing full screen video of the triggered camera.
 - d. Providing screen prompting to the system operator.

2. The set of Intelligent Video Analysis algorithms shall provide the following functionality:
 - a. Alert Types:
 - 1) Smart Video Motion Detection. This VSA shall have algorithms to filter out minor vibrations. The sensitivity of this filter shall be user adjustable. This VSA shall also provide motion masking where the user can define an area of the frame where motion will be ignored.
 - 2) Camera Tampering. When the VSA detects a camera is moved from its original position, when the camera view is obstructed, or when the focus is changed, this VSA shall activate.
 - 3) Sudden Change in Light Intensity. This VSA shall trigger when there is an extreme change in ambient light - light to dark or dark to light. The sensitivity of this VSA shall be user definable.
 - 4) New Object in Scene. This VSA shall detect an object that was not present when the VSA originally learned the scene or that has been inserted into the scene in a user defined area in the field of view.
 - 5) Object Removed from Scene. When an object that was present when the VSA originally learned the scene view has been removed from the scene, this VSA shall activate. This VSA shall be capable of being applied to a window of the total field of view as defined by the user.
 - 6) Specific Object Detected in Scene. This VSA shall trigger when an object is detected that is defined by specific properties including people, automobiles, or an object of a specific color.
 - 7) Congestion in Defined Area. This VSA shall occur when the VSA detects congestion in a specific area of the scene as defined by the user.
 - 8) Directional Motion VSA shall occur when the VSA detects an object moving in a direction specified in the setup of this feature.
 - 9) Object Crosses a Defined Region. This VSA shall detect an object moving across a virtual boundary or into a defined area from a specified direction.
 - 10) Moving Object Stops. This VSA shall detect when a moving object in the scene ceases to move.
 - 11) Static Object Starts to Move. VSA shall occur when the VSA detects when a static object in the scene starts to move.
 - 12) Object Moves Too Fast. This VSA shall trigger when an object is moving faster than a pre-defined speed.
 - 13) Loitering. This VSA shall detect when a person or group of people in the scene slows down or ceases to move for a specified period of time.
 - 14) Detection of a Human Face. This VSA shall trigger when the VSA detects a frontal view of a human face.

- 15) People Counting. This VSA shall be used when a camera is positioned in a top-down view of an entry/exit portal. This feature shall provide an alarm with a positive count for entry and a negative count for exit.
 - b. The VSA shall support the ability to store the graphical output for a specific event for use with VSA alarms. This feature shall allow the graphical output of a specific event to be stored as a file and later used as an overlay to be used and associated with an alarm for historical searching.
 - c. The VSA shall support CIF, 4CIF, and D1 video resolutions during video processing.
 - d. The VSA shall support video infrared imaging.
3. License Plate Recognition:
 - I. Intelligent Audio Analysis:
 1. The NVMS shall provide the ability to perform analysis on audio streams associated with recorded video.
 2. Supported audio analytics shall include high pitched sounds, impact sounds, or other dramatic changes to a defined ambient noise threshold.
 3. When searching for these audio alarms, the search shall include video stored locally or on an archive destination.
 - J. The NVMS shall provide up to 10 different and independent programmable recording schedules.
 1. The schedules may be programmed to provide different record frame rates for day, night, and weekend periods, as well as holidays and exception days.
 2. Advanced task schedules may also be programmed that could specify allowed log-on times for user groups, when events may trigger alarms, and when data backups and archiving should occur.
 - K. The VMS shall support Dual Authorization logon. It shall function as follows:
 1. Dual Authorization user groups may be created.
 2. Logon pairs, consisting of any two normal user groups, may be assigned to each Dual Authorization user group.
 3. A separate set of privileges and priorities can be assigned for each Dual Authorization user group.
 4. For each user group assigned as part of a logon pair, it shall be configurable whether the group can:
 - a. Log on either individually or as part of the logon pair.
 - b. Log on only as part of the logon pair.
 5. If a user that is part of logon pair logs on individually, then the user shall receive the privileges and priorities of the user's assigned user group. If the same user logs in as part of a logon pair, then the user shall receive the privileges and priorities assigned to the Dual Authorization group to which the pair is assigned.
 - L. The NVMS shall auto-discover cameras and encoders. Device detection shall support devices in different subnets.

- M. The NVMS shall be designed in such a way that server downtime or loss of communication to the server does not affect the functionality of the recording services. Normal recording and motion recording shall continue during server downtime.,

2.5 NVMS RECORDING REQUIREMENTS

- A. The NVMS shall provide management of the recording and playback of video, audio, and data (bookmarking, alarm data, etc.).
- B. Refer to the Camera Schedules on the project drawings for specific variables to be used on a per-camera basis for the purpose of calculating storage capacity and retention.
 - 1. Total distributed storage requirements shall be determined based on a minimum of <Insert> days storage retention.
 - 2. Cameras, unless otherwise noted on the Camera Schedule(s), shall be assumed to be recording 24 hours per day, 7 days per week, 365 days per year. Specific per-camera assumptions stated on the Camera Schedule for percent motion shall be used in the storage calculation.
 - 3. Compression shall be permitted to be used in the storage calculation. The compression algorithm (MPEG-4, H.264, etc.) shall be used on a per-camera basis. If the NVMS permits variable levels of compression intensity, the use of the "average" or "medium" level setting shall be used in the storage calculation unless otherwise noted.
- C. Network Video Recorder (NVR) Hardware Platform:
 - 1. The NVR shall be defined as a storage device for recording IP video streams from IP cameras or from analog cameras that have been encoded to IP. In both cases, the NVR shall record IP streams from cameras or encoders located anywhere on the IP network without being direct-cable connected to the NVR.
 - 2. Refer to the project drawings for specific requirements, model numbers, and basis of design for the NVR.
 - 3. NVR Configuration:
 - a. The NVR shall contain one hard drive for the operating system and software, and all hard drive storage required to achieve the required storage retention.
 - b. Provide with RAID 5 hard disk controller configuration for the video storage hard drives.
 - 4. The NVMS shall provide a failover function where an NVR can be assigned as a backup to other NVRs. When an assigned NVR goes out of service, the failover NVR takes over the responsibilities of the failed NVR. When the primary NVR returns to service, the control shall be automatically transferred back to the primary NVR.
 - 5. It shall be possible to assign a redundant NVR to every NVR for use in normal operation of all NVR(s) in the system. The redundant NVR shall record the same streams as the primary NVR. The redundant NVR shall have its own disk drives where it shall store the recorded data.

- a. It shall be possible to view the data recorded by the redundant NVR in the client software. The redundant NVR shall have camera symbols that can be placed in the camera selection tree. These cameras shall have the same name as the cameras of the primary NVR. An indication shall be provided to indicate that the camera names are located on the redundant NVR.

2.6 NVMS ALARM REQUIREMENTS

- A. The NVMS shall provide the capability to accept external alarm triggers in the following formats:
 1. Momentary or maintained low voltage contact closures
 2. Digital I/O (0 / 10V DC)
 3. RS-232 integration
- B. Alarms shall be capable of being scheduled such that they are only active during defined times.
- C. The NVMS shall allow alarms to be individually restricted to specific user groups or users.
- D. A single alarm event shall be capable of activating a series of output events including:
 1. Mark recorded video.
 2. Initiate an email, text message, or both.
 3. Initiate an on-screen alarm prompt in a segmented "Alarm Queuing Window."
 4. Modify recorded video settings including resolution and frame rate.
 5. Modify video viewing options including bringing associated video full screen on any output.
- E. The alarm queue shall display alarms in order of their priority, with rows for higher priority alarms always displayed above lower priority alarm rows. The display order for equal priority alarms shall be selectable between new alarms displayed above existing alarms or new alarms displayed below existing alarms.
- F. Alarm Processing: The video management system shall operate as follows:
 1. When an alarm is accepted by a user, it shall be removed from the other users' alarm lists.
 2. The user shall be able to cancel acceptance of any alarm that has been previously accepted. In this case, the alarm shall re-appear in the alarm lists of all members of the user groups assigned to this alarm.
- G. The NVMS shall support the association of workflows with alarms. Workflows shall consist of action plans and comment boxes. An action plan shall display a text document, HTML page, or web site that typically contains instructions for handling the alarm. Comments entered in the comment boxes shall be logged in the system logbook.
 1. The NVMS shall be configurable to force an alarm workflow. In this case, the alarm cannot be cleared until the workflow is processed.
- H. The NVMS shall offer the possibility to automatically clear alarms when the originating event condition is no longer true.

- I. Alarms shall be capable of being configured to send cameras to defined positions.

2.7 NVMS INTERFACES AND INTEGRATIONS

A. Security Management System Integration:

1. Refer to the project drawings for all information regarding the Security Management System (SMS).
2. The NVMS shall be integrated with the SMS to provide communication and alarm functionality between the two systems defined as follows, at a minimum:
 - a. Any alarm/event in the SMS shall have the ability to be associated with a digital video clip in real time.
 - 1) The NVMS shall support user-defined video marking that includes time before and after the alarm event.
 - 2) SMS alarm events shall be capable of triggering a defined video sequence of operation.
 - b. The NVMS shall support NVMS PTZ control via the SMS video interface.
 - c. The integration shall support bidirectional alarm monitoring, alerting, and acknowledgement for either system from either system.
 - 1) Both alarm acknowledgement and alarm reset shall be supported.
 - d. Video Camera Groups/Video Camera Tours:
 - 1) The NVMS shall support camera grouping to allow for video camera tours in the SMS Alarm Monitoring Module.
 - 2) An unlimited number of camera groups shall be supported in the SMS, and each camera group shall support an unlimited number of cameras. Cameras within a camera group shall be capable of spanning any storage media. Individual cameras shall have the ability to be placed into multiple camera groups.
 - 3) The SMS shall provide for video camera tours that rotate live video between each of the cameras defined in the video camera group at a user-defined increment. The time increment shall be user definable in whole seconds.
3. The integration shall be:
 - a. An integrated product from a single manufacturer, such that a single manufacturer supplies, supports, and warrants the entire solution including the integration.
 - b. An integration of two separate companies through ONLY an open API/SDK. The API/SDK integration must be complete, functional, and in use in the marketplace. The ability to integrate through an API/SDK without the integration being done in the marketplace is not acceptable. Custom or proprietary integrations are not acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with the manufacturer's instructions and recommendations for installation of all products.
- B. Provide all system wiring between all components as shown on the project drawings or as directed by the manufacturer, whichever is the more stringent requirement.
- C. Mount all cameras in the approximate locations shown on the drawings. Coordinate installation with other trades and utilities in the vicinity. Cameras containing fixed lenses, moved by more than 1'-0" from their location shown on the drawings, shall have a new lens calculation performed by the Contractor. Provide Architect/Engineer with results of lens calculation before proceeding with installation.
- D. Coordinate with Owner's IT Department to acquire network connections as well as any network configuration information, such as IP numbers, that will be required to connect NVMS to Owner network (if applicable).
- E. Provide all low voltage and +120 VAC power to all devices as required for proper system operation. Refer to Sections 26 05 33 and 26 05 13 for further requirements.
- F. All low voltage security wiring shall be routed and supported separately from all other telecommunications cabling.
- G. Cabling shall be plenum rated when installed outside of conduit in plenum ceilings.

3.2 FIELD QUALITY CONTROL

- A. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product that meets the requirements of the specifications as supplied and warranted by the system vendor. If the product or assembly is not available from the system vendor, provide product or assembly as recommended by the system vendor.
- B. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the project drawings.
- C. It shall be the Contractor's responsibility to correct all inadequate picture quality issues prior to acceptance of the system.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Installation shall be performed by a factory-trained and certified Contractor.
 - 1. Provide a comprehensive, site-specific customer planning guide for the system. Conduct a conference with the Owner prior to any installation to discuss the programming options of the system and the planning guide. The result of this planning guide shall be the determination of the system options for each device and for the software.

- B. Include labor for all planning and all programming activities required to implement the Owner's operational preferences for each device and software. Any software programmable option, within the bounds of the capabilities of the hardware specified, shall be included.
- C. Provide a complete, functional system as described by the project drawings. These responsibilities include:
 - 1. Complete hardware setup, installation, wiring, and software configuration of the system, including all remote operator locations and all peripheral hardware.
 - 2. Complete programming of all hardware and software options in accordance with the Owner's preferences as determined by the planning guide conference.
 - 3. Programming of all custom graphic GUI screens including devices.
 - 4. Complete system diagnostic verification.
- D. Provide an authorized manufacturer representative to commission the system and ensure that facility-wide standards and project setup procedures are adhered to.

3.4 SYSTEM ACCEPTANCE

- A. Submit for review a formal acceptance and system checkout program. The system checkout procedures shall include all system components and software. Perform the tests and document all results under the supervision of the manufacturer's system engineer.
- B. All operational scenarios, as defined by the customer planning guide, shall be tested to simulate the actual use of the system in the normal operating environment. The successful completion of these operational scenarios shall be documented.

3.5 SYSTEM DOCUMENTATION

- A. Complete documentation shall be provided for the system. The documentation shall describe:
 - 1. All operational parameters of the system.
 - 2. Complete documentation of all programming and options.
 - 3. Complete operating instructions for all hardware and software.
- B. The following sections shall be provided in the system documentation:
 - 1. System Administrator Manual: Provides an overview and a step-by-step guide and instructions detailing all system administrator responsibilities and functions.
 - 2. User Manual: A step-by-step guide and instructions detailing all system user functions.
 - 3. Technical Maintenance Manual: A comprehensive document providing all maintenance actions, system testing schedules, troubleshooting flowcharts, functional system layout, wiring diagrams, block diagrams, and schematic diagrams.

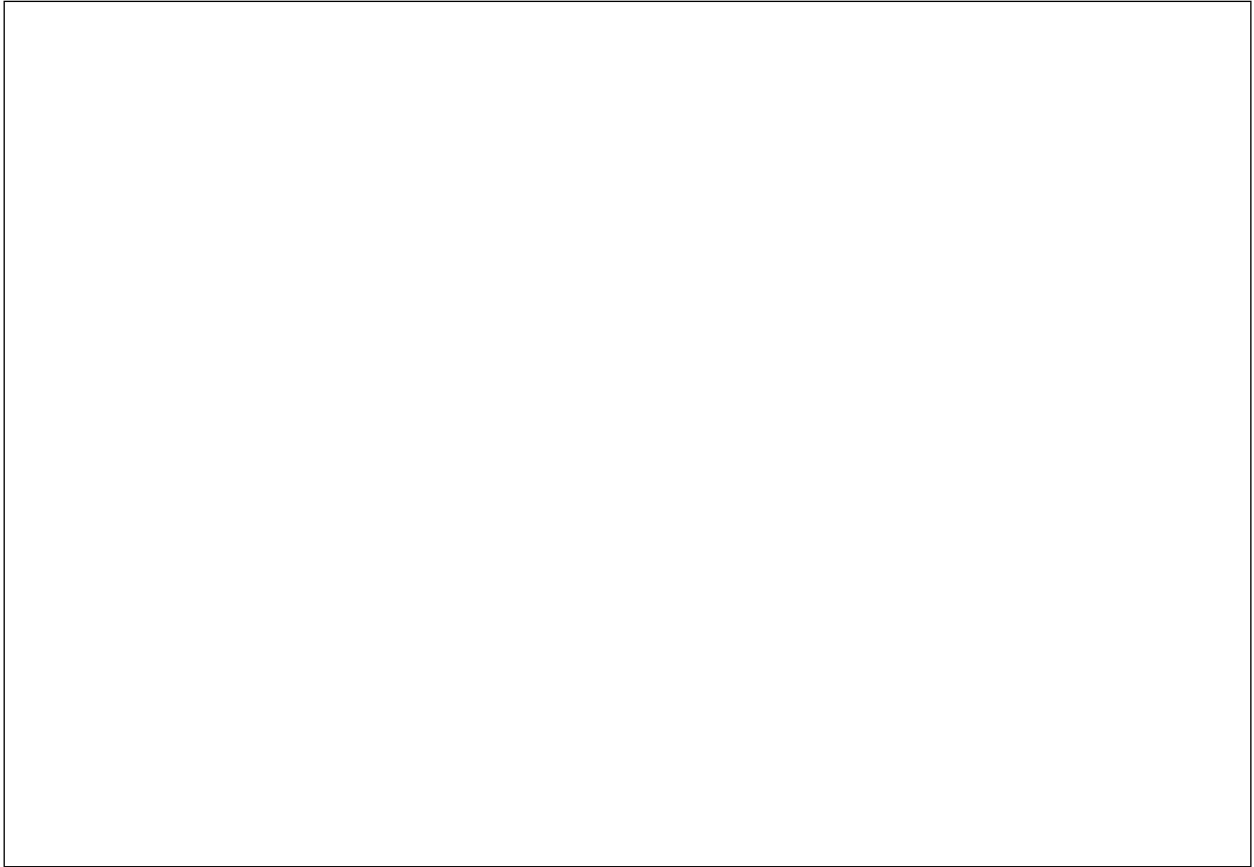
3.6 SYSTEM TRAINING

- A. All labor and materials required for on-site system training by a certified representative of the system manufacturer shall be provided. Training shall be conducted at the project site using the project equipment.

- B. Provide two weeks advanced notice of training to the Owner.
- C. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.
- D. At a minimum, the following training shall be conducted:
 - 1. System Administrators: A course detailing the system functions and operations. Provide configuration training on all aspects of the system.
 - 2. Users: Provide a detailed course outlining the operational features of all aspects of the user interface. Topics shall include alarm monitoring functions, reports, error handling, alarm handling, output relay control, and general overview of the report hardware.
 - 3. GUI Editing: Conduct detailed training on using the GUI editing software. Topics shall include the editing of existing graphical maps and the creation of new graphical maps.
- E. Minimum on-site training times shall be:
 - 1. System Administrators: Three (3) days.
 - 2. Users: One (1) day.
 - 3. GUI Editing: One (1) day.

NVMS Bid Inventory Form

Item	Cost/Other
Total fixed (lump sum cost) for the entire project:	
Itemize the total fixed lump sum cost as follows:	
Software cost for NVMS including all implementation services.	
Cost for all camera hardware and associated accessories.	
Itemize software cost for the following (show the math):	
Fixed, non-reoccurring flat base cost (if any)	
Fixed, non-reoccurring per-camera licensing fee (if any)	
Recurring flat base cost (if any - do NOT include optional software maintenance agreement costs)	
Recurring flat per-camera licensing fee (if any)	



END OF SECTION

SECTION 28 3100 - FIRE ALARM AND DETECTION SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fire alarm and detection systems.

1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in smoke detection and fire alarm systems with ten years' experience.
- B. Installer: A factory-authorized Electrical or Security Contractor licensed with the State and local jurisdiction with five years' experience in the design, installation, and maintenance of fire alarm systems by that manufacturer.
- C. Qualifications: The person managing/overseeing the preparation of shop drawings and the system installation/programming/testing shall be trained and certified by the system manufacturer and shall be Fire Alarm Certified by NICET, minimum Level 2. This person's name and certification number shall appear on the start-up and testing reports.

1.3 REFERENCES

- A. ASME A17.1 - Safety Code for Elevators and Escalators
- B. NFPA 20 - Standard for Centrifugal Fire Pumps
- C. NFPA 70 - National Electrical Code (NEC)
- D. NFPA 72 - National Fire Alarm and Signaling Code
- E. NFPA 101 - Life Safety Code
- F. UL 2017 - General Purpose Signaling Devices and Systems
- G. UL 217 / 268 - Standard for Smoke Alarms / Smoke Detectors for Fire Alarm Systems

1.4 SUBMITTALS

- A. Provide product catalog data sheets as shop drawings.
 - 1. Provide a product catalog data sheet for each item shown on the Electrical Symbols List and for each piece of equipment that is not shown on the drawings, but required for the operation of the system.

2. Where a particular Electrical Symbols List item has one or more variations (such as those denoted by subscripts, etc.) a separate additional product catalog data sheet shall be provided for each variation that requires a different part number to be ordered. The corresponding Electrical Symbols List symbol shall be shown on the top of each sheet.
 3. Where multiple items and options are shown on one data sheet, the part number and options of the item to be used shall be clearly denoted.
- B. Submit CAD Floor Plans as Shop Drawings:
1. The complete layout of the entire system, device addresses, auxiliary equipment, and manufacturer's wiring requirements shall be shown.
 2. Indicate the precise routing of notification appliance circuits under the provisions of circuit survivability. Refer to "Wiring" under Part 3 - Execution of this specification section for requirements.
 3. A legend or key shall be provided to show which symbols shown on the submittal floor plans correspond with symbols shown on the Contract Documents.
- C. About all fire alarm circuits, provide the following: manufacturer's wiring requirements (manufacturer, type, size, etc.) and voltage drop calculations.
- D. Submit manufacturer's certificate that system meets or exceeds specified requirements.
- E. Provide information on the system batteries as follows: total battery capacity, total capacity used by all devices on this project, total available future capacity.
- F. Submit photocopy proof of NICET certification of the person overseeing the preparation of drawings and installation/testing.
- 1.5 REGULATORY REQUIREMENTS
- A. System: UL or FM Global listed.
 - B. Conform to requirements of NFPA 101.
 - C. Conform to requirements of Americans with Disabilities Act (ADA).
 - D. Conform to UL 864 Fire Alarm, UL 1076 Security, UL2017 General Signaling
- 1.6 SYSTEM DESCRIPTION
- A. Performance Statement: This specification section and the accompanying fire alarm specific design documents describe the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment described and the performance required of the system, as presented in these documents, the Vendor and the Contractor are solely responsible for determining all wiring, programming and miscellaneous equipment required for a complete and operational system.

- B. This section of the specifications includes the furnishing, installation and connection of the microprocessor controlled, intelligent reporting, fire alarm equipment required to form a complete coordinated system that is ready for operation. It shall include, but is not limited to, alarm initiating devices, control panels, auxiliary control devices, annunciators, power supplies, and wiring as indicated on the drawings and specified herein.
 - C. Fire Alarm System: NFPA 72; Automatic and manual fire alarm system, non-coded, analog-addressable with automatic sensitivity control of certain detectors, multiplexed signal transmission.
 - D. System Supervision: Provide electrically supervised system, with supervised Signal Line Circuit (SLC) and Notification Appliance Circuit (NAC). Occurrence of single ground or open condition in initiating or signaling circuit places circuit in TROUBLE mode. Component or power supply failure places system in TROUBLE mode.
 - E. Drawings: Only device layouts and some equipment have been shown on the contract drawings. Wiring and additional equipment to make a complete and functioning system has not been shown, but shall be submitted on the shop drawings.
- 1.7 PROJECT RECORD DOCUMENTS
- A. Include location of end-of-line devices.
 - B. Provide a CAD drawing of each area of the building (minimum scale of 1/16" = 1'-0") showing each device on the project and its address. The devices shall be shown in their installed location and shall be labeled with the same nomenclature as is used in the fire alarm panel programming.
 - C. Submit test results of sound pressure level (dBA) and intelligibility (STI) with the rooms tested designated on the floor plan. Notification devices shall have the tap wattage designated.
- 1.8 OPERATION AND MAINTENANCE DATA
- A. Include operating instructions, and maintenance and repair procedures.
 - B. Include manufacturer's representative's letter stating that system is operational.
 - C. Include the CAD floor plan drawings.
 - D. Include shop drawings as reviewed by the Architect/Engineer and the local Authority Having Jurisdiction.
- 1.9 WARRANTY
- A. Provide one (1) year warranty on all materials and labor from Date of Substantial Completion.
 - B. Warranty requirements shall include furnishing and installing all software upgrades issued by the manufacturer during the one (1) year warranty period.

1.10 ANNUAL INSPECTION/TESTING AND SERVICE CONTRACT

- A. The Owner may enter into a contract directly with the vendor after shop drawing submittals. This specification is not a contract between the Owner and the vendor to perform these services.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Fire-Lite
- B. Notifier by Honeywell
- C. Edwards - EST

2.2 FIRE ALARM CONTROL PANEL (FAP)

- A. Control Panel: Modular, power-limited electronic design. Provide surface wall-mounted enclosure as shown on plans. Enclosure shall be minimum 0.060 steel with provisions for electrical conduit connections into the sides and top. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators.
- B. Each Signaling Line Circuit (SLC loop) shall not be loaded over 80% of the maximum device capacity. For example, in the minimum system capacity column listed below, if the fire alarm manufacturer's system capacity of analog sensors per loop is 99 devices, then no more than 79 devices shall be wired on that loop. The minimum system capacity shall be as follows:
 - 1. Minimum Total Addressable Points: 250
 - 2. Minimum Total SLC Loops (including board, ready for field connections): 1
 - 3. Panel Expansion Capability, Minimum Total SLC Loops: 2
- C. Signal Line Circuit (SLC) and Notification Appliance Circuit (NAC) Boards:
 - 1. Each board shall communicate directly with each addressable analog sensor and binary input to determine normal, alarm, or trouble conditions. Analog signals would be used for automatic test and determination of maintenance requirements.
 - 2. Each board shall contain its own microprocessor and shall be provided to monitor addressable inputs and to control addressable outputs (addressable relays). The board shall communicate and provide power to all devices on its loop over a single pair of wires, except where 4-wire devices require a separate power circuit.
- D. Central Processing Unit:
 - 1. The central processing unit (CPU) shall communicate with the monitor and control all other modules in the panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the CPU.
 - 2. The CPU shall execute all control-by-event programs for specific action to be taken if a designated situation is detected in the system. A real-time system clock for time annotations on the display and printer shall be included.

3. All power for the unit shall be supervised and supplied by the FAP.
- E. Display:
1. The board shall provide all controls and indicators used by the system operator and may also be used to program all control panel parameters.
 2. The board shall provide an alphanumeric array for display of custom alphanumeric labels for all addressable points. It shall also provide indicators for AC Power, System Alarm, System Trouble, Display Trouble and Signal Silence.
 3. Displayed descriptions of addressable points shall include actual room names/numbers selected by the Owner. This information shall be obtained prior to programming. Room names/numbers shown on floor plans shall not be used.
 4. The board shall provide a touch key-pad with control capability to command all system functions and entry of any alphanumeric information. Twenty different passwords with four levels of security shall be supported to prevent unauthorized manual control or programming.
- F. Memory: The CPU and display interface board shall be augmented by non-volatile field programmable memory. EPROM memory will also be allowed provided the memory is burned in with minimum expansion capability equal to the total system capacity of the panel. Memory shall not be lost upon primary and secondary power failure.
- G. Power Supply:
1. Input power shall be 120 VAC, 60 Hertz. Output power shall be as noted on the device specifications and drawings. Each component of the fire alarm system requiring 120 VAC input power shall be served from a dedicated branch circuit. Provide two #12 conductors and one #12 ground in 3/4" conduit to a dedicated 20A/1P circuit breaker with a red handle and a manufacturer's standard handle lock-on device. Identify/label breaker and branch circuit in accordance with NFPA requirements and Specification Section 26 0553.
 2. Adequate to supply 125% of all control panel and peripheral power needs as well as 125% of power required for all external audio-visual devices. The power supply may be increased as needed by adding additional modular expansion power supplies. Over-current protections shall be provided on all power outputs.
 3. All power supplies shall be designed and installed to meet UL and NFPA requirements for power-limited operation on all external initiating and indicating circuits.
 4. The power supply shall provide integral charger for use with internal batteries. Battery capacity shall be sufficient for operation of the entire system for 24 hours in a non-alarm state followed by alarm mode for 15 minutes, plus 25% spare capacity for future devices.
- H. Surge Protection:
1. All fire alarm control panels, NAC panels, etc. shall be provided with a surge protection device (SPD). The SPD shall be UL listed to Standard 1449 Rev 3. The unit should be clearly labeled in accordance with Identification Section 26 0553. The SPD shall have thermal fuses to protect against fire in short circuit conditions. The unit shall provide visual indication that the unit is protecting and functioning.
 2. Any communications or signaling circuits associated with the fire alarm system, which leave or enter a facility, shall be provided with a surge protection device. The devices shall be as recommended by the fire alarm system manufacturer.

- I. Digitized Voice Command Center (VCC): Include integral with fire alarm system.
 1. The Digitized Voice Command Center (VCC) shall contain all equipment required for all audio control signaling, and supervisory functions. This shall include digital voice units, speaker zone indication, and main firefighter phone handset.
 2. Function: The Voice Command Center equipment shall perform the following functions:
 - a. Operate as a supervised single channel automatic digitized voice evacuation system with manual emergency voice communication system.
 - b. Dual channel speaker circuits shall be arranged such that there is a minimum of one (1) speaker circuit per floor of the building or smoke zone, whichever is greater.
 - c. Operate as a two-way emergency firefighter phone system control center. The two-way emergency telephone system shall support a minimum of seven (7) handsets on line without degradation of the signal.
 - d. Audibly and visually annunciate the active or trouble condition of every signal circuit
 - e. Audibly and visually annunciate any trouble condition of tone generators and digital voice units required for normal operation of the system.
 - f. Provide all-call activities through activation of a single control switch.
 - g. Provide automatic, digitally recorded voice messages and tones.
 3. Audio Amplifiers (AMP): Include integral with fire alarm system.
 - a. The audio amplifiers will provide a single channel audio power at 25/70 volts RMS for distribution to speaker circuits.
 - b. The audio amplifier shall include an integral power supply, and shall provide the following controls and indicators:
 - 1) Normal Audio Level LED
 - 2) Incorrect Audio Level LED
 - 3) Battery Trouble LED
 - 4) Amplifier Trouble LED
 - 5) Audio Amplifier Gain Adjust
 - c. Includes audio input and amplified output supervision backup input.
 4. Audio Message Generator (Digitized Voice):
 - a. Each initiating zone or intelligent device shall interface with an emergency voice communication system capable of transmitting a digitized voice message to all speakers in the building.
 - b. Actuation of any alarm initiating device shall cause a digitized message to sound over the speakers. The message shall be repeated four (4) times.
 - c. A built-in microphone shall be provided to allow paging through speaker circuits.
 - d. The audio message generator shall have the following controls and indicators to allow for proper operator understanding and control:
 - 1) All Call LED
 - 2) On-Line LED
 - 3) All Call Switch

5. Voice Messages:

- a. A pre-programmed custom digital voice message shall be used for notification appliance speaker circuits. The messages shall be approved by the Authority Having Jurisdiction (AHJ). Voice messages shall be from a female voice. The messages shall be provided in the multi-lingual language of the predominant building population.
- b. Message shall be preceded by a tone and message shall be repeated four times until silenced.
- c. Messages shall be annunciated by a single channel in all evacuation signal zones throughout the building.
- d. Fire Alarm Pre-Recorded Messages: Refer to drawings for fire alarm pre-recorded message schedule. Message shall be as shown in the schedule.

6. Speaker Circuit Control Switches/Indicators:

- a. The speaker circuit control switches/indicators shall include visual indication of active and trouble status for each speaker circuit in the system.
- b. The speaker circuit control panel shall include switches to manually activate or de-activate each speaker circuit in the system.
- c. Buttons shall be provided on the voice command center to manually activate all auxiliary messages. (i.e. all clear, severe weather, homeland security warning, custom message).

2.3 SIGNALING LINE CIRCUIT DEVICES

- A. Combination Devices: Subscripts identify combination type devices when applicable. Contractor shall provide the combination device or provide multiple device(s) to meet the functionality when the manufacturer does not offer the required functionality with a single device.
- B. Signal Line Device(s):
 1. Subscripts: Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
- C. FA-120; Smoke Detectors:
 1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
 2. (BLANK) Analog Photoelectric Type Sensor: Shall use the photoelectric principle to measure smoke density and send data to the control panel representing the analog level of smoke density measured.
 3. Each smoke detector shall connect directly to an SLC loop, unless listed as stand alone.
 4. Each detector shall be mounted, where shown on the drawings, on a twist-lock base with all mounting hardware provided. Provide a two-piece head/base design.

5. Each detector shall have a manual switching means to set the internal identifying code (address) of that detector, which the control panel shall use to identify its address with the type of sensor connected.
 6. Dual alarm and power indicators shall be provided that flash under normal conditions and remain continuous under alarm or trouble conditions. Remote indicator terminals shall be provided. Provide a remote LED indicator device if detector is not visible from a floor standing position.
 7. A test means shall be provided to simulate an alarm condition.
 8. Where operation is noted as required below 32°F and/or above 120°F, a conventional device shall be installed with a unique monitor module located in the nearest available location with maintained temperatures between 32°F and 120°F.
- D. FA-122; Duct Smoke Detectors, Sampling Tube Type:
1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
 - a. Duct-type smoke detectors shall use the same analog photoelectric sensor technology, with the same features specified for standard smoke detectors, except with additional features as specified below.
 - b. Provide sampling tubes and mounting hardware to match the duct to which it is attached. Where the detector housing is larger than the duct height, Contractor shall fabricate a mounting bracket for the detector and attach according to the fire alarm manufacturer's recommendations.
 - c. Provide a remote alarm LED indicator device (FA-241) if detector is not visible from a floor-standing position. If detector is located above a suspended ceiling, mount remote indicator in ceiling directly below detector with a white single-gang faceplate labeled: Duct Smoke Detector.
- E. FA-130; Manual Pull Stations:
1. Manual pull station, addressable, double action, reset key lock, semi-flush mount, red high abuse plastic or cast metal construction with white lettering. Provided with all necessary mounting hardware.
 2. Manual stations shall connect directly to an SLC loop. Stations shall provide address setting means using rotary decimal or DIP switches.
 3. Where operation is noted as required below 32°F and/or above 120°F, a conventional device shall be installed with a unique monitor module located in the nearest available location, with maintained temperatures between 32°F and 120°F.
- F. FA-160; Monitor Modules:
1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
 2. Monitor Module shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit. It shall interface initiating devices with the control panel using Style D or Style B circuits. Contractor Option: Use an interface module (2-wire operation) for Style B circuits connected to normally-open dry contacts, such as a flow switch.

3. The module shall be mounted in an enclosure located in an accessible service location as near as possible to the device(s) being monitored, or where shown on the drawings. All mounting hardware shall be provided.
4. The module shall supply the required power to operate the monitored device(s).
5. The module shall provide address setting means using rotary decimal or DIP switches.

G. FA-161; Addressable Control Module:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation
2. Relay that represents an addressable control point used primarily for the control of auxiliary devices as indicated on the drawings. Contractor to provide additional child relay(s), as required, rated for the electrical load being controlled (Contractor to match voltage, amps, etc.).
3. Relay shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit.
4. The relay shall be mounted in an enclosure located in an accessible service location as near as possible to the device(s) being controlled, unless otherwise shown on the drawings. All mounting hardware shall be provided.
5. The relay shall supply 24 VDC power to the device(s) being controlled, unless otherwise indicated on the drawings.

2.4 NOTIFICATION APPLIANCE DEVICES

A. Combination Devices: Subscripts identify combination type devices when applicable. Contractor shall provide the combination device or provide multiple device(s) to meet the functionality when the manufacturer does not offer the required functionality with a single device.

B. Notification Appliance Device(s):

1. Subscripts: Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.

a. Device types as follows:

- 1) W = Weather Proof
- 2) Candela Ratings:

a) ## = 15 Candela; 30 Candela; 75 Candela; 110 Candela; 177 Candela

C. Notification Device(s):

1. Wall Mounted: Red housing with white lettering or pictogram.
2. Ceiling Mounted: Red housing with white lettering or pictogram.

D. Visual Alarm Devices:

1. Wall or ceiling mounted, refer to plans.
2. High intensity (Candela rating as scheduled on the drawings) xenon strobe or equivalent under a lens. Candela rating shall be visible from exterior of the device.

3. The maximum pulse duration shall be 0.2 seconds with a maximum duty cycle of 40%. The flash rate shall be 1 Hz. Where more than two strobes are visible from any one location, the fire alarm visual devices shall be synchronized.
 4. Device, housing, and backbox shall be UL listed for fire alarm/emergency applications.
 5. (W) Weatherproof Visual Notification Device: High intensity strobe, square housing, 75 Candela rating, suitable for wet locations. Provide with weatherproof back box.
 - a. Mounting: Semi-flush wall.
 - b. Conduit shall not be exposed.
- E. Audio (Speaker) Alarm Devices:
1. Wall or ceiling mounted, refer to plans.
 2. Sound rating shall be dependent on the tap (wattage) setting. Tap settings shall be available in 3 dBA increments. A minimum of four (4) tap settings should be available to allow field adjustment of the sound output across a minimum range of 78 to 87 dBA, 400Hz to 4KHz (6 dBA cutoff) frequency range. Speakers shall operate on a 25V RMS system, unless otherwise noted on drawings.
 3. Speakers shall clearly reproduce a signal consisting of a live or prerecorded human voice and background music with voice intelligibility.
 4. Speaker, housing, and backbox shall be UL listed for fire alarm/emergency applications.
 5. Wall Mounted: Speaker, square housing, flush or semi-flush mounted.
 6. Ceiling Mounted: 4" speaker, round housing, flush mounted (provide tile bridge where applicable).
- F. FA-221; Combination Audio (Voice) and Visual Alarm Device:
1. Wall or ceiling mounted, refer to plans.
 2. Combine speaker and visual components into a single device. Refer to the corresponding paragraphs above for requirements of each component.
 3. (W) Weatherproof Voice/Visual Notification Device: Speaker with high intensity 75 Candela rated strobe. 25 VRMS with a minimum of four (4) tap settings which shall allow field adjustment of the sound output across a minimum range of 78 to 87 dBA (UL 1480), 400 Hz to 4 KHz (6dBA cutoff) frequency range.
 - a. Mounting: Semi-flush wall.
 - b. Conduit shall not be exposed.
- 2.5 NOTIFICATION APPLIANCE CIRCUIT PANEL (NAC)
- A. As shown on the plans or as a Contractor's option if not shown, furnish and install NAC extender panels as necessary to provide remote power supply for notification appliance circuits (NAC). Contractor shall indicate quantity and locations of each NAC on the shop drawing submittals.
 - B. Each NAC shall be self-contained remote power supply with batteries, and battery charger mounted in a surface lockable cabinet. Battery capacity shall be sufficient for operation for 24 hours in a non-alarm state followed by alarm for 15 minutes, plus 25% spare capacity for future devices. Each NAC provides a minimum of up to 4 outputs, 2A continuous, or 6A full load total capacity.

- C. Power for each NAC shall be from a local 120 VAC circuit. Provide two #12 conductors and one #12 ground in 1/2" conduit to each NAC from a dedicated 20A/1P circuit breaker with a red handle and a manufacturer's standard handle lock-on device. Coordinate panel and circuit number with the Architect/Engineer prior to installation.
- D. NAC extender panels may be installed only in locations coordinated with the Architect/Engineer.
- E. Mounting: Surface.

2.6 ANNUNCIATION

- A. FAA; Remote LCD Annunciators:
 - 1. Auxiliary annunciators shall indicate alarm and trouble conditions visually and audibly as shown on the drawings. Provide local TROUBLE ACKNOWLEDGE, TEST, and ALARM SILENCE capability. Minimum 80-character display.
 - 2. Communications and power to the annunciators shall be supervised. The annunciator shall receive power from the fire alarm control panel.
 - 3. A single key switch shall enable all switches on the annunciator.
 - 4. Mounting: Flush.
- B. FA-241; Fire Alarm Remote Indicator:
 - 1. Red LED type.
 - 2. Mounts flush to a single gang box.

2.7 CONNECTIONS TO AUXILIARY DEVICES PROVIDED BY OTHERS

- A. Flow Switch:
 - 1. Connection to flow switch to monitor fire protection flow switch or discharge output contacts. Normally open dry contacts for fire alarm interface. Furnished and installed by MC; wired by EC.
 - 2. Provide a dedicated monitor switch for each sprinkler flow switch.
- B. Tamper / Monitor Switch:
 - 1. Connection to monitor switch to monitor fire protection system supervisory switches or output contacts. Normally open dry contacts for fire alarm interface. Furnished and installed by MC; wired by EC.
 - 2. Tamper switches in the same room or system may be monitored by a single monitor switch when shown grouped on the plans.
 - 3. (PIV) Post Indicator Valve. Connection to post indicator valve for sprinkler system supervisory notification. Normally open dry contacts for fire alarm interface. Furnished and installed by MC; wired by EC. Provide surge protection device as recommended by the fire alarm system manufacturer on line entering/leaving the facility.
- C. Electronic Bell:

1. Electronic bell for sprinkler alarm, electro-mechanical type, 120 VAC. Furnished and installed by MC. Fire alarm control and power connections by EC.

2.8 WIRING

- A. Fire alarm wiring/cabling shall be furnished and installed by the Contractor in accordance with the manufacturer's recommendations and pursuant to National Fire Codes. Cabling shall be UL listed and labeled as complying with the Electrical Code for power-limited fire alarm signal service.
- B. Fire Alarm Cable:
 1. Manufacturers:
 - a. Comtran Corp.
 - b. Helix/HiTemp Cables, Inc.
 - c. Rockbestos-Suprenant Cable Corp.
 - d. West Penn Wire/CDT.
 - e. Radix.

PART 3 - EXECUTION

3.1 SEQUENCES OF FIRE ALARM OPERATION

- A. General:
 1. Refer to the Fire Alarm Operation Matrix on the drawings for basic requirements and system operation.
 2. All system output programs assigned via control-by-event equations to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.
- B. Panel/Annunciator Alarm, Trouble, Supervisory Indication:
 1. Appropriate system Alarm, Trouble, or Supervisory LED shall flash at the control panel, transponder, and annunciator locations.
 2. A local signal in the control panel shall sound.
 3. The LCD display shall indicate all information associated with the condition, including the name of the item, type of device and its location within the protected premises.
 4. Transmit the appropriate signal (supervisory, trouble, alarm) to the central station via the digital communicator.
 5. Transmit the appropriate signal (supervisory, trouble, alarm) to the building automation system via addressable relays tied to contact monitors on the system.
- C. Audible Alarms Sequence:
 1. Audible alarms throughout the building shall sound.
 2. Separate voice announcements shall be played in different fire compartments depending on proximity to the device that initiated the alarm. Refer to the requirements above for the Voice Command Center programming.

- D. Visual Alarms Sequence:
 - 1. Visual alarms throughout the building shall flash.
 - E. Fire Protection Electric Sprinkler Bell Sequence:
 - 1. The fire alarm shall utilize an addressable relay to energize the electric sprinkler bell upon activation of the flow switch.
 - F. Mechanical Fan Shutdown Sequence:
 - 1. The fire alarm system shall utilize addressable relays to de-energize all AHU motor controllers and mechanical fans. Coordinate other requirements with HVAC installer.
 - 2. The fire alarm system shall directly shut down the AHU or mechanical fan through the local HVAC control device (i.e., variable frequency drive or motor starter).
 - 3. Where a facility has more than one AHU or mechanical fan, each shall be shutdown individually based on input from initiation devices in the area served by the unit or designated for each air distribution system.
 - G. Access Control Override Sequence:
 - 1. The fire alarm shall use addressable output relay(s) to signal the access control panel.
 - 2. Refer to the access control specifications for requirement upon fire alarm signal.
- 3.2 INSTALLATION
- A. Install system in accordance with manufacturer's instructions and referenced codes.
 - B. Fire Alarm Control Panel:
 - 1. Install the control panel where shown on the drawings.
 - 2. All expansion compartments, if required, shall be located at the control panel.
 - 3. Install the voice command center and fire command center in the location as indicated on the drawings. This location should be primary fire department "attack" location. Coordinate with the local fire department prior to submitting shop drawings.
 - 4. The fire alarm voice prerecorded messages shall be verified by the Contractor, as approved by the Owner, prior to the shop drawing submittal process.
 - C. Devices:
 - 1. General:
 - a. All ceiling-mounted devices shall be located where shown on the reflected ceiling and floor plans. If not shown on the reflected ceiling or reflected floor drawings, the devices shall be installed in the relative locations shown on the floor drawings in a neat and uniform pattern.
 - b. All devices shall be coordinated with luminaires, diffusers, sprinkler heads, piping and other obstructions to maintain a neat and operable installation. Mounting locations and spacing shall not exceed the requirements of NFPA 72.

- c. Where the devices are to be installed in a grid type ceiling system, the detectors shall be centered in the ceiling tile.
 - d. The location of all fire alarm devices shall be coordinated with other devices mounted in the proximity. Where a conflict arises with other items or with architectural elements that will not allow the device to be mounted at the location or height shown, the Contractor shall notify the Architect/Engineer to coordinate a different acceptable location.
 2. Per the requirements of NFPA, detector heads shall not be installed until after the final construction cleaning unless required by the local Authority Having Jurisdiction (AHJ). If detector heads must be installed prior to final cleaning (for partial occupancy, to monitor finished areas or as otherwise required by the AHJ), they shall not be installed until after the fire alarm panel is installed, with wires terminated, ready for operation. Any detector head installed prior to the final construction cleaning shall be removed and cleaned prior to closeout.
 3. Protection of Fire Alarm System:
 - a. A smoke detector shall be installed within the vicinity of the main fire alarm panel and every NAC extender panel per NFPA 72. A heat detector may be substituted when a smoke detector is not appropriate for the environment of installation.
 4. Duct-type Analog Smoke Detectors:
 - a. Duct-type analog smoke detectors shall be installed on the duct where shown on the drawings and details. The sampling tubes shall be installed in the respective duct at the approximate location where shown on the electrical drawings to meet the operation requirements of the system.
 - b. All detectors shall be accessible.
 - c. Duct-type detectors shall be installed according to the manufacturer's instructions.
 5. Manual Pull Stations:
 - a. Stations shall be located where shown and at the height noted on the drawings.
 6. Addressable Relays and Monitor Modules:
 - a. Modules shall be located as near to the respective monitor or control devices as possible, unless otherwise indicated on the drawings.
 - b. All modules shall be mounted in or on a junction box in an accessible location.
 - c. Where not visible from a floor standing position, a remote indicator shall be installed to allow inspection of the device status from a local floor standing location.
 7. SLC Loop Isolation Modules:
 - a. Isolation modules shall be installed to limit the number of addressable devices that are incapacitated by a circuit fault.
 - b. Install all Isolation Modules within the fire alarm control panel, unless otherwise indicated on the drawings. Refer to the fire alarm riser diagram for requirements. Refer to the floor plans for areas served by separate isolation modules.

8. Notification Appliance Devices:
 - a. Devices shall be located where shown on the drawings.
 - b. Wall-mounted audio, visual and audio/visual alarm devices shall be mounted as denoted on the drawings.
 - c. Where ceiling mounted visual alarm devices or combination audio/visual alarm devices are shown where the ceiling is greater than 30'-0" high, they shall be stem mounted so that the entire unit is below 30'-0". This does not apply to audio-only alarm devices.

- D. Annunciators:
 1. Remote Annunciators: The annunciators shall be located where shown on the drawings and approved by the fire marshal.

- E. Wiring:
 1. Fire alarm wiring/cabling shall be provided by the Contractor in accordance with the manufacturer's recommendations and pursuant to National Fire Codes.
 2. Refer to Identification Section 26 0513 for color and identification requirements.
 3. Wiring shall be installed in conduit from device to above accessible ceilings. Exposed plenum-rated cable (FPLP) shall be used above accessible ceilings supported every 4 feet or run in cable trays (if applicable) maintaining a minimum of 5-inches clearance from all lighting ballasts. Fire alarm cabling shall not be installed in the same bridle rings or cable trays designated for the cabling of other systems.
 4. All junction boxes with SLC and NAC circuits shall be identified on cover. Refer to Identification Section 26 0513 for color and identification requirements.
 5. Fire Alarm Power Branch Circuits: Building wiring as specified in Section 26 0513.
 6. Notification Appliance Circuits shall provide the features listed below. These requirements may require separate circuits for visual and audible devices.
 - a. Fire alarm temporal audible notification for all audio appliances.
 - b. Synchronization of all visual devices where two or more devices are visible from the same location.
 - c. Ability to silence audible alarm while maintaining visual device operation.
 7. Signal line circuits connecting devices shall be provided with an isolation module at each floor separation or as otherwise shown on the drawings.
 8. No wiring other than that directly associated with fire alarm detection, alarm or auxiliary fire protection functions shall be in fire alarm conduits. Wiring splices shall be avoided to the extent possible, and if needed, they shall be made only in junction boxes, and enclosed by plastic wire nut type connectors. Transposing or changing color coding of wires shall not be permitted. All conductors in conduit containing more than one wire shall be labeled on each end, in all junction boxes, and at each device with "E-Z Markers" or equivalent. Conductors in cabinets shall be carefully formed and harnessed so that each drops off directly opposite to its terminal. Cabinet terminals shall be numbered and coded, and no unterminated conductors are permitted in cabinets or control panels. All controls, function switches, etc. shall be clearly labeled on all equipment panels.

- F. Devices surface mounted in finished areas shall be mounted on surface backboxes furnished by fire alarm equipment supplier. Backboxes shall be painted to match device, shall be the same shape and size as the device shall not have visible knockouts.
- G. Make conduit and wiring connections to door release devices, sprinkler flow and pressure switches, sprinkler valve monitor switches, fire suppression system control panels, duct analog smoke detectors and all other system devices shown or noted on the Contract Documents or required in the manufacturer's product data and shop drawings.

3.3 FIELD QUALITY CONTROL

- A. Test in accordance with NFPA 72, Chapter 14 and local fire department requirements. Submit documentation with O & M manuals in accordance with Section 14.6 of the Code.
- B. Contractor shall test and adjust the fire alarm system as follows:
 - 1. Speaker taps shall be adjusted to the lowest tap setting which achieves a sound level higher than or equal to the greatest of the following:
 - a. 70dBA.
 - b. 15 dBA above ambient levels as indicated in NFPA 72 Table A.18.4.3.
 - c. 15 dBA above measured ambient. 5 dBA above the maximum measured sound level with duration of more than 60 seconds.
 - 2. Sound level measurement procedure shall meet the following requirements:
 - a. All measurements shall use the 'A' weighted, dBA, sound measurement scale.
 - b. All measurements shall be taken after furnishings, wall coverings and floor coverings are in place.
 - c. All measurements shall be taken after fixed equipment (HVAC units, etc.) producing ambient noise is installed and is in operation.
 - d. Final ambient sound measurements shall be taken during occupancy and the units shall be re-adjusted at that time, if necessary.
 - e. All sound level measurements shall be taken at a height of 5' above the finished floor level.
 - f. Measurements shall be taken in every unique room. If there are multiple rooms, which have the identical dimensions and function, 10%, or a minimum of two (2) rooms shall be tested. The results from the rooms tested shall be averaged and the remaining rooms may be adjusted per the average.
 - g. Measurements shall be taken on a 20' x 20' grid and the results for all points taken shall be averaged. If the room is smaller than 20' x 20' a minimum of two measurements are required.
 - h. Measurements shall be taken halfway between speakers or halfway between a speaker and the wall. No measurements shall be taken at the extreme edges of the room, nor directly under speakers.
- C. Additionally, test the voice alarm communication system intelligibility per IEC 60849:
 - 1.

3.4 MANUFACTURER'S FIELD SERVICES

- A. Include services of certified technician to supervise installation, adjustments, final connections, and system testing.
- B. Note that room numbers depicted on the architectural/engineering drawings will not necessarily reflect the actual room (signage) numbers that the Owner selects. Contractor and fire alarm manufacturer shall coordinate the actual room numbers as the Owner directs to identify each device. This list shall be a part of the floor plan record drawing to be turned in at the project closeout.
- C. Include the services to train up to three of the Owner's staff in operation, maintenance, and programming of the fire alarm system at the manufacturer's factory.

END OF SECTION

SECTION 31 2214 - EARTHWORK FOR SITEWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes earthwork required to complete the Project except as specified in related work. Includes earthwork related to synthetic grass field.

1.2 SUBMITTALS

- A. Samples
 - 1. Submit 10 lb samples of each material to be used. Identify source, type (use) of each material and gradation. Forward to testing agency packed tightly in containers to prevent contamination. Submit copy of transmittal to Architect.
- B. Submit invoices and delivery tickets indicating the amount and type of off-site materials delivered.
- C. Submit sediment and erosion plan, specific to the site that complies with EPA 832/R-92-005 "Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices".

1.3 QUALITY ASSURANCE

- A. Codes and Standards: Perform Work in compliance with applicable requirements of governing authorities having jurisdiction.
- B. Soil Testing and Inspection Service:
 - 1. The Owner will engage a soil testing and inspection service, to include testing soil materials proposed for use in the Work and initial quality control testing during earthwork operations.
 - 2. Furnish soil survey for satisfactory soil materials and samples of soil materials to the testing service.

1.4 PROJECT CONDITIONS

- A. Site Information
 - 1. The Owner has had a subsurface investigation performed, the results of which are contained in a report. The report presents conclusions on the subsurface conditions based on there interpretation of the data obtained in the investigation.
 - 2. The Contractor acknowledges that they have reviewed the report and any addenda thereto.

3. It is recognized that a subsurface investigation may not disclose all conditions as they actually exist and other conditions may change, particularly groundwater conditions, between the time of a subsurface investigation and the time of earthwork operations.
 4. The data on indicated subsurface conditions are not intended as representations or warranties of the continuity of such conditions. It is expressly understood that the Owner and Architect will not be responsible for interpretations or conclusions drawn therefrom by the Contractor. The data are made available for the convenience of the Contractor.
 5. Additional test borings and other exploratory operations may be made by the Contractor at no cost to the Owner.
- B. Traffic: Conduct operations to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities. Do not close or obstruct streets, walks or other occupied or used facilities without permission from authorities having jurisdiction.
- C. Protection of Existing Improvements:
1. Provide barricades, coverings, or other types of protection necessary to prevent damage to existing improvements to remain in place.
 2. Restore damaged improvements to their original condition, as acceptable to the Owners and other parties or authorities having jurisdiction.
- D. Protection of Existing Vegetation:
1. Protect existing vegetation to remain in place against unnecessary cutting, breaking or skinning of roots, skinning and bruising of bark, smothering by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. Provide temporary fences, barricades or guards as required to protect vegetation to be left standing.
 2. Water as required to maintain health during the course of construction operations.
 3. Protect root systems from damage due to noxious materials in solution caused by runoff or spillage during mixing and placement of construction materials, or drainage from stored materials. Protect root systems from flooding, erosion or excessive wetting resulting from dewatering operations.
 4. Do not allow fires under or adjacent to plantings which are to remain.
 5. Provide protection for roots over 1½" diameter that are cut during construction operations. Coat the cut faces with an emulsified asphalt or other acceptable coating especially formulated for horticultural use on cut or damaged plant tissues. Temporarily cover all exposed roots with wet burlap to prevent roots from drying out; provide earth cover as soon as possible.
 6. Repair or replace vegetation damaged by construction operations, in a manner acceptable to the Architect.
 7. Repair tree damage by a qualified tree surgeon. Replace trees, which cannot be repaired and restored to full-growth status, as determined by the tree surgeon at no cost to the Owner.
- E. Improvements on Public Property: Obtain authority for performing removal and alteration Work on public property.

F. Existing Utilities:

1. Locate existing underground utilities in the areas of Work before starting earthwork operations. If utilities are to remain in place, provide adequate means of protection during earthwork operations.
2. Contact JULIE (800-892-0123) to verify locations of existing underground utilities before starting excavation.
3. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult the Architect immediately for directions as to procedure.
4. Cooperate with the Owner and public and private utility companies in keeping their respective services and facilities in operation.
5. Demolish and completely remove from the site underground utilities indicated to be removed. Coordinate with local utility companies for shutoff of services if lines are active.

G. Use of Explosives: The use of explosives shall not be permitted.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General Fill: Provide soil materials conforming to ASTM D2487 soil groups GW, GR, GM, SW, SP or SM or a combination that are free of debris, waste, frozen materials, vegetable, organic and other deleterious matter and having maximum particle size of 2" in all dimensions
- B. Select Fill: Clean natural or crushed stone or gravel conforming to State of Illinois, Department of Transportation Gradation CA 6.
- C. Underbed Material: Naturally or artificially graded mixture of natural or crushed stone or gravel conforming to State of Illinois, Department of Transportation Specifications for Gradation CA 8, or CA 7.
- D. Use Contractor supplied off-site material except that general fill may be from excavation if found acceptable by the Contractor's testing service. Provide all materials required to complete the Work in the Contract.

2.2 ACCESSORIES

- A. Drainage Fabric: Non-woven geotextile, specifically manufactured as a drainage geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:
 1. Grab Tensile Strength: 110 lbf (490 N); ASTM D 4632.
 2. Tear Strength: 40 lbf (178 N); ASTM D 4533.
 3. Puncture Resistance: 50 lbf (222 N); ASTM D 4833.
 4. Water Flow Rate: 150 gpm per sq. ft. (100 L/s per sq. m); ASTM D 4491.
 5. Apparent Opening Size: No. 50 (0.3 mm); ASTM D 4751.

- B. Separation Fabric: Woven geotextile, specifically manufactured for use as a separation geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:
 - 1. Grab Tensile Strength: 200 lbf (890 N); ASTM D 4632.
 - 2. Tear Strength: 75 lbf (333 N); ASTM D 4533.
 - 3. Puncture Resistance: 90 lbf (400 N); ASTM D 4833.
 - 4. Water Flow Rate: 4 gpm per sq. ft. (2.7 L/s per sq. m); ASTM D 4491.
 - 5. Apparent Opening Size: No. 30 (0.6 mm); ASTM D 4751.

- C. Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:

- D. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, minimum 6 inches and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:
 - 1. Red: Electric.
 - 2. Yellow: Gas, oil, steam, and dangerous materials.
 - 3. Orange: Telephone and other communications.
 - 4. Blue: Water systems.
 - 5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 TEMPORARY EROSION CONTROL

- A. Before mobilizing and starting Work on the site, institute, expand as necessary, and maintain throughout the project a sediment and erosion control system that complies with EPA 832/R-92-005 and as required by authorities having jurisdiction.

- B. Control erosion and sediment damage to roadways, adjacent properties and water resources through the use of basins, ditch checks, temporary ditches, mulch barriers, mulches, grasses, silt filter fences, hay or straw bales, aggregate barriers, inlet and pipe protection and other appropriate means.

- C. Remove and legally dispose of debris resulting from the project when no longer required in accordance with authorities having jurisdiction.

3.2 CLEARING

- A. General:

1. Remove vegetation, improvements, or obstructions that interfere with installation of new construction. Removal includes new and old stumps and their roots.
2. Carefully and cleanly cut roots and branches of vegetation to be left standing, where such roots and branches obstruct new construction.
3. Comply with the environmental protection and safety requirements of all authorities having jurisdiction. Keep dust to a minimum. Maintain streets free of mud, dirt and debris.

B. Topsoil Removal:

1. Topsoil is defined as friable clay loam surface soil found in a depth of not less than 4". Satisfactory topsoil is reasonably free of subsoil, clay lumps, stones, and other objects, and without weeds, roots, and other objectionable material.
2. Strip topsoil to whatever depths encountered, and in such manner so as to prevent intermingling with the underlying subsoil or other objectionable material. Remove heavy growths of grass from areas before stripping.
3. Where vegetation is to be left standing, stop topsoil stripping a sufficient distance from such vegetation to prevent damage to the main root system.
4. Stockpile top soil in storage piles for reuse or remove from the site. Furnish acceptable topsoil at no cost to Owner. Construct storage piles to freely drain surface water. Cover storage piles if required to prevent windblown dust.

C. Removal of Improvements:

1. Remove improvements that interfere with construction.
2. Cap and remove abandoned underground piping or conduit.
3. Where uncharted or incorrectly charted below grade improvements are discovered, obtain approval of Architect before removal.

3.3 EXCAVATION

A. General:

1. Excavation consists of the removal and disposal of materials encountered when establishing the required grade elevations. Such excavation is unclassified regardless of the materials encountered and all materials to be disposed of in accordance with authorities having jurisdiction.
2. Unauthorized excavation consists of removal of materials beyond indicated or required elevations. Replace unauthorized excavation by backfilling and compacting as specified for select fill at no cost to Owner.
3. Excavate under pavements as required to comply with cross sections, elevations and grades.
4. Excavate elsewhere as required to establish new finish grades, allowing not less than 4" for topsoiling.

B. Dewatering:

1. Prior to commencing work, the Contractor shall provide a storm water management plan. This plan shall stipulate provisions for dewatering, pumping, collection, temporary storage, and discharge or disposal of storm water, perched water and other liquids, contaminated and/or uncontaminated, at the site so as to facilitate soil removal and minimize disposal costs for contaminated fluids.
2. Do not allow water to accumulate in excavations. Remove water from excavations to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to the stability of subgrades and foundations. Provide and maintain pumps, sumps, suction and discharge lines, and other dewatering system components necessary to convey the water away from the site.
3. Convey water removed from excavations and rainwater to collecting or run-off areas acceptable to authorities having jurisdiction. Do not use trench excavations for site utilities as temporary drainage ditches.

C. Stability of Excavations:

1. Slope the side of excavations to comply with local codes and authorities having jurisdiction and maintain same. Secure, shore, and brace where sloping is not possible either because of space restrictions or stability of material excavated.
2. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.

D. Shoring and Bracing:

1. Provide shoring and bracing to comply with local codes and authorities having jurisdiction.
2. Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross braces, in good serviceable conditions.
3. Maintain shoring and bracing in excavations regardless of the time period excavations will be open. Carry down shoring and bracing as the excavation progresses.

E. Material Storage: Stockpile excavated materials classified as satisfactory soil material onsite as applicable for backfill or fill. Place, grade and shape stockpiles for proper drainage.

F. Excavation for Structures:

1. Excavate to the subgrade elevations required within a tolerance of plus or minus 0.10' to balance, and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, other construction required, and for inspection.
2. Take care not to disturb the bottom of the excavation. Excavate by hand to final grade just before concrete is placed. Trim bottoms to the required lines and grades to leave a solid base to receive concrete.

G. Excavation for Pavements: Cut the surface under pavements to comply with cross sections, elevations and grades.

H. Removal of Unsatisfactory Soil Materials:

1. Excavate unsatisfactory soil materials encountered that extend below the required elevations, to the additional depth established by the Owner's testing service and approved by Owner.
2. If excavated unsatisfactory materials are to be removed from the property, all such materials shall be disposed of in accordance with authorities having jurisdiction.
3. Such additional excavation, provided it is not due to the fault or neglect of the Contractor, will be measured and paid for as a change in the Work if approved by Owner.

I. Closing Abandoned Underground Utilities: Close open ends of abandoned underground utilities, which are to remain permanently, and with sufficiently strong closures to withstand pressures which may result after closing.

J. Cold Weather Protection: Protect excavation bottoms against freezing when the atmospheric temperature is less than 35 degrees F. Maintain excavation free of water, ice and snow.

3.4 PROOF ROLLING

- A. Proof Roll entire area under pavements and synthetic turf with a pneumatic roller or heavily loaded dump truck (minimum 25 tons).
- B. Make at least two (2) passes (second at right angle to first) in the presence of a representative of the Contractor's testing service.
- C. Excavate unsatisfactory soil materials encountered to the additional depth established by the Contractor's testing service and approved by Owner.
- D. Perform no further Work until slab subgrades are acceptable to the representative of the Contractor's testing service.

3.5 COMPACTION

- A. General: Control soil compaction during construction, providing the minimum percentage of density specified.
- B. Percentage of Maximum Density Requirements: Provide not less than the following percentages of density of soil material compacted at + 2% optimum moisture content, for the actual density of each layer of soil material-in-place:
 1. Compact top 12" of subgrade and each layer of backfill or fill material to 95% maximum density (ASTM D 1557). This includes the subgrade of the synthetic turf field.
- C. Moisture Control:
 1. Where the subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to the surface of subgrade, or layer of soil material, to

prevent free water appearing on the surface during or subsequent to compaction operations.

2. Remove and replace, to scarify and air dry, soil material that is too wet to permit compaction to specified density.

3.6 BACKFILL AND FILL

A. Prior to Backfill Placement: Backfill excavations as promptly as the Work permits, but not until completion of the following:

1. Review of construction below finish grade.
2. Code required inspection, testing, approval, and recording locations of underground utilities.
3. Removal of concrete formwork.
4. Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Cut off temporary sheet piling driven below bottom of structures and remove in manner to prevent settlement of the structure or utilities, or leave in place if required.
5. Removal of trash and debris.
6. Permanent or temporary horizontal bracing is in place on horizontally supported walls.

B. Ground Surface Preparation:

1. Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow, strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material bonds with existing surface.
2. When the existing ground surface has a density less than that specified under "Compaction" for the particular area classification, break up the ground surface, pulverize, bring moisture condition to the optimum moisture content, and compact to the required depth and percentage of maximum density.

C. Placement and Compaction:

1. Place backfill and fill materials to required grades in layers not more than 8" in loose depth for materials compacted by heavy compaction equipment and not more than 4" in loose depth for materials compacted by hand operated tampers. Before compaction, moisten or aerate each layer as necessary to provide the optimum moisture content of the soil material. Compact each layer to the required percentage of density.
2. Place backfill and fill materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.
3. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
4. Backfill and fill under pavements as required to comply with cross sections, elevations and grades shown.

- a. Use select fill material. Use of existing onsite native soil and general fills to bring site to proposed subgrade elevation must be approved by the onsite testing agency, geotechnical engineer, and civil engineer of record.
5. Backfill and fill elsewhere as required to establish new finished grades, allowing not less than 4" for top soiling using select fill except below 3-foot, general fill may be used.

3.7 GRADING

- A. General: Uniformly grade the area, including adjacent transition areas. Smooth finished surfaces within specified tolerances, compact with uniform levels or slopes between elevation points, or between such points and existing grades.
- B. Grassed Areas: Finish areas to receive topsoil to within not more than 0.10' above or below the required subgrade elevations, compacted as specified, and free from irregular surface changes.
- C. Walks: Shape the surface of areas under walks to line, grade and cross section, with the finish surface not more than 0.00' above or 0.10' below the required subgrade elevation, compacted as specified, and graded to prevent ponding of water after rains.
- D. Pavements: Shape the surface of the areas under pavement to line, grade and cross section, with the finish surface not more than 1/4" above or below the required subgrade elevation, compacted as specified, and graded to prevent ponding of water after rains.

3.8 FIELD QUALITY CONTROL

- A. Quality Control Testing During Construction:
 1. The Owner's testing service must inspect and approve sub-grades and fill layers before further construction work is performed thereon.
 2. If, in the opinion of the Owner's testing service, based on reports of the testing service and inspection, the subgrade or fills which have been placed are below the specified density, additional compaction and testing shall be required until satisfactory results are obtained at no additional cost to Owner. In such event, retesting shall be paid by the Contractor.
- B. The Owner will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during earthwork operations.
- C. Contractor's Responsibilities
 1. Notify onsite testing agency sufficiently in advance of operations to allow for assignment of personnel and scheduling of tests.
 2. Coordinate with Agencies' personnel; provide access to Work, to manufacturer's operations.
 3. Provide preliminary representative samples of materials to be tested, in required quantities.

4. Furnish casual labor and facilities to provide access to Work to be tested to obtain and handle samples at the site to facilitate inspections and tests, and storage and curing of tests.
5. Arrange with laboratory, pay for, additional samples and tests required when initial tests indicate Work does not comply with Contract Documents.

D. Tests for Proposed Soil Materials:

1. Test soil materials proposed for use in the Work and promptly submit test result reports. Soil samples shall be provided by Contractor.
2. Provide one optimum moisture-maximum density curve for each type of cohesive soil. Determine maximum densities in accordance with ASTM D 1557.
3. Determine the suitability of materials to be used as fill and backfill.
4. Perform a mechanical analysis (AASHTO T88), plasticity index (AASHTO T91), and frost susceptibility analysis.

E. Compaction Testing:

1. Inspect, test, and approve each lift of fill and backfill before next lift is placed. Test in accordance with ASTM D1556 or ASTM D2167 as appropriate.
2. Field density tests may be performed by the nuclear method in accordance with ASTM D 6938. The calibration curves shall be periodically checked and adjusted to correlate to tests performed using ASTM D1556 or ASTM D2167. Calibration of nuclear density testing device shall be in accordance with ASTM D7759.
3. If field tests are performed using nuclear methods, the inspection and testing agency shall make calibration checks on both density and moisture gauges at beginning of work, on each different type of material encountered, and at intervals as specified by the equipment manufacturer.
4. Take a field density test for each 2,000 sq. ft. of backfill and fill under slabs and pavements.
5. Take a field density test at 50 foot intervals along utility trench backfill under slabs and pavements.

F. Proofrolling Observation:

1. Provide continuous observation of proofrolling operations. Four passes shall be made.
2. Subgrade must be approved by onsite testing agency prior to backfill.

G. Submittals: Submit copies of the following reports:

1. Report and certification of granular fill and drainage fill.
2. Test reports on fill and backfill material.
3. Field density test reports.
4. One optimum moisture-maximum density curve for each type of soil encountered.
5. Report of actual unconfined compressive strength and/or results of plate bearing tests of each strata tested.
6. Other tests' and materials' certificates, as required.

3.9 MAINTENANCE AND RESTORATION

- A. Protection of Graded Areas:
 - 1. Protect newly graded areas from traffic and erosion, and keep free of trash and debris and growth of weeds.
 - 2. Repair and reestablish grades in settled, eroded, and rutted areas to the specified tolerances.

- B. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather scarifies the surface, reshape, and compact to the required density prior to further construction.

- C. Restoration: Restore all areas affected by construction both on and off Owner's property to original condition.

3.10 DISPOSAL OF EXCESS AND WASTE MATERIALS

- A. Burning is not permitted on the Owner's property.

- B. Remove waste materials, excess excavated materials, excavated materials classified as unsatisfactory soil material from the Owners property and legally dispose of all materials.

END OF SECTION

SECTION 31 2317 - EXCAVATING, BACKFILLING, AND COMPACTING FOR UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the following:
 - 1. Excavation for - trenches for water and sewer lines to public utility.
 - 2. Compacted bed and compacted fill over utilities to subgrade elevations.
 - 3. Compaction.

1.2 SUBMITTALS

- A. Submit samples in accordance with General Conditions of contract and Division 01 Sections.
- B. Submit 10 lb. sample of each type of fill to testing agency, in separate airtight containers.

1.3 TESTS

- A. Tests and analysis of fill materials will be performed in accord with ASTM D1557 and with General Conditions.

1.4 REFERENCES

- A. ASTM C136, - Sieve Analysis of Fine and Coarse Aggregates.
- B. ASTM D1556, - Density of Soil in place by Sand-Cone Method.
- C. ASTM D1557, - Tests for Moisture-Density Relationship of Soils and Soil-Aggregate Mixtures Using 10 lb. Rammer and 18-inch Drop.
- D. Illinois Department of Transportation (IDOT):
 - 1. IDOT Specifications for Road and Bridge Construction, latest edition, including all addenda.

1.5 PROTECTION

- A. Protect excavations by shoring, bracing, sheet piling, underpinning or other methods or prevent cave-in or loose soil from falling into excavation.
- B. Underpin adjacent structures which may be damaged by excavation work, including service utilities and pipe chases.

- C. Notify Architect immediately of unexpected subsurface conditions. Confirm notification in writing. Discontinue work until Architect issues written notification to resume work.
- D. Protect bottom of excavations and soil adjacent to and beneath foundations from frost.
- E. Grade excavation tip perimeter to prevent surface water runoff into excavation.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. In accordance with the soil report the Contractor's testing agency representative shall determine if the excavated material is suitable for backfill. The suitable trench excavated material shall be used for trench backfill.
- B. Granular Fill Type A:
 - 1. Material for granular fill shall be CA-11 or CA-13 in compliance with IDOT 2020, Article 703.1 and 703.5.
 - 2. Bedding Material: Material for bedding shall be CA-11 in compliance with IDOT 2020, Article 704.01 and 703.5.
- C. Fill Material Type D: Fill material shall be cohesive soil obtained from on-site required excavations and approved by the Contractor's testing agency representative as suitable backfill material in accordance with ASTM D 2487, Uniform Soils Classification System 1 and 703.5. It shall be used to backfill excavations where the excavated material is unsuitable for backfill.
- D. Fill Material Type E: Fill under landscaped areas shall be free from alkali and salt and shall be obtained from on-site required excavations when conforming to the specifications. This fill shall be approved by the Contractor's testing agency representative as suitable material.
- E. Fill Material Type X: Off-site borrow material shall comply to soil types GP, GW, SC and CL in accordance with ASTM D 2487, Uniform Soils Classification. It shall be used where needed under structural slabs, roads, pavement and landscaped areas.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Verify stockpiled fill to be reused as approved in writing by Architect.
- B. Verify and confirm in writing that areas to be backfilled are free of debris, snow, ice or water, and surfaces are not frozen.

3.2 PREPARATION

- A. Identify specified lines, levels, contours and data.
- B. Compact subgrade surfaces to density specified for backfill materials.

3.3 EXCAVATION

- A. Cut trenches wide enough to enable utility installation and allow inspection.
- B. Hand trim excavation and leave free of loose matter. Hand trim for bell and spigot pipe joints.
- C. Excavation shall not interfere with normal 45 degree bearing splay of foundations.
- D. Sides, walls or faces of all trenches shall be sloped and maintained in a safe manner and in the required condition until completion of backfilling. Excavations shall be braced or sloped in compliance to the latest Occupational Safety and Health Administration (OSHA) requirements or as instructed by the testing agency on-site representative.
- E. Locate and retain reusable excavated materials away from the edge of excavation.

3.4 BACKFILLING

- A. Support pipes, and conduits during placement and compaction of bedding fill.
- B. Backfill trenches to contours and elevations shown. Backfill systematically, as early as possible to allow maximum time for natural settlement. Do not backfill over porous, wet or spongy subgrade surfaces.
- C. Place compact fill materials in continuous layers as specified in Section "Earthwork."
- D. Use a placement method that will not disturb or damage utilities in trenches, perimeter drainage.
- E. Maintain optimum moisture content of backfill materials, determined by laboratory analysis, to obtain specified compaction density.

3.5 FILL TYPES AND COMPACTION

- A. Compact all fill and backfill to specified values based on Modified Proctor Test in accordance with Section "Earthwork."

3.6 QUALITY CONTROL

- A. Quality Control Testing During Construction: An independent inspection and testing agency employed by the Owner shall inspect and approve each subgrade and fill layer before further backfill and fill work is performed.

1. The inspection and testing agency shall perform laboratory density tests in accordance with ASTM D 1557.
2. Field density tests shall be in accordance with ASTM D1556 or ASTM D2167 as appropriate.
3. Field density tests may be performed by the nuclear method in accordance with ASTM D 6938. The calibration curves shall be periodically checked and adjusted to correlate to tests performed using ASTM D 1556. Calibration of nuclear density testing device shall be in accordance with ASTM D7759.
4. If field tests are performed using nuclear methods, the inspection and testing agency shall make calibration checks on both density and moisture gauges at beginning of work, on each different type of material encountered, and at intervals as specified by the equipment manufacturer.
5. If, in the opinion of the Owner's testing agency representative, based on the inspection and testing agency reports and inspections, subgrade or fills have been placed by specified density, the Contractor shall perform additional compaction and retesting until specified density contractor to pay for all retesting work.
6. The Contractor shall assist the inspection and testing agency by providing access to the excavation and fill areas, and by removing loose materials from compacted soil layers prior to testing.

3.7 REMOVAL AND DISPOSAL

- A. Remove surplus backfill materials and materials unsuitable for backfill from the site and legally dispose of offsite according to authorities having jurisdiction.

END OF SECTION

SECTION 31 32 19 – GEOSYNTHETIC SOIL STABILIZATION AND LAYER SEPARATION

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. Separation Geotextile (Subgrade CBR ≥ 3):
 - a. This section is applicable to the use of a geotextile to prevent mixing of subgrade soil and an aggregate cover material (subbase, base, select fill, etc.) as well as separation between multiple base course layers.
 - b. This section may also apply to situations other than beneath pavements where separation of two dissimilar materials is required, but where water seepage through the geotextile is not a critical function.

- B. Related Requirements:

1. Section 01 81 13 "Green Globes Certification Procedures" for all the applicable requirements."
2. Section 32 91 13 "Soil Preparation."

1.3 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO) "Standard Specification for Geotextile Specification for Highway Applications" Designation M 288-06

- B. AASHTO Test Standards:

1. T 88 – Standard Test Method for Particle Size Analysis of Soils
2. T 90 – Standard Test Method for Determining the Plastic Limit and Plasticity Index of Soils
3. T 99 – Standard Practice for Determination of the Moisture Density Relations of Soils Using a 5.5 lb hammer and 12 in drop (Standard Proctor)

- C. American Society for Testing and Materials (ASTM):

1. D 123 – Standard Terminology Relating to Geotextiles
2. D 276 – Standard Test Method for Identification of Fibers in Textiles
3. D 422 - Standard Test Method for Particle-Size Analysis of Soils

4. D 4354 - Practice for Sampling of Geosynthetics for Testing.
5. D 4355 - Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).
6. D 4439 - Terminology for Geotextiles.
7. D 4491 - Test Methods for Water Permeability of Geotextiles by Permittivity.
8. D 4595 - Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
9. D 4533 - Test Method for Index Trapezoid Tearing Strength of Geotextiles.
10. D 4632 - Test Method for Grab Breaking Load and Elongation of Geotextiles.
11. D 4759 - Practice for Determining the Specification Conformance of Geosynthetics.
12. D 4751 - Test Method for Determining Apparent Opening Size of a Geotextile.
13. D 4759 - Practice for Determining the Specification Conformance of Geosynthetics
14. D 4884 - Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Geotextiles
15. D 4873 - Guide for Identification, Storage, and Handling of Geotextiles.
16. D 5321 - Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
17. D 6241 - Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe
18. D 6706 - Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil

D. Federal Highway Administration (FHWA) - Geosynthetic Design and Construction Guidelines, Publication No. FHWA NHI-07-092, August 2008.

E. Geosynthetic Accreditation Institute - Laboratory Accreditation Program (GAI-LAP).

F. D.International Standards Organization (ISO) - 9001:2008

G. E. National Transportation Product Evaluation Program (NTPEP)

1.4 PERMITS AND FEES

A. Permits: The Contractor shall secure and pay for all permits, inspections, and certificates of inspection of any governmental and inspection body having jurisdiction over all or any part of the work included under this section and/or such inspections etc., required by these specifications.

B. Fees: The Contractor shall secure and pay for all fees and assessments in connection with the work under this contract and shall include this cost in its bid and contract price.

1.5 DEFINITIONS

A. California Bearing Ratio (CBR): The ratio of (1) the force per unit area required to penetrate a soil mass with a 19 sq cm (3 sq in) circular piston (approximately 51 mm (2 in) diameter) at the rate of 1.3 mm / min (.05 in/min). To (2) that required for corresponding penetration of a standard material.

- B. Maximum Average Roll Value (MaxARV): Property value calculated as typical plus two standard deviations. Statistically, it yields a 97.7 percent degree of confidence that any sample taken during quality assurance testing will be below the value reported.
- C. Minimum Average Roll Value (MARV): Property value calculated as typical minus two standard deviations. Statistically, it yields a 97.7 percent degree of confidence that any sample taken during quality assurance testing will exceed value reported.
- D. Typical *Roll Value*: Property value calculated from average or mean obtained from test data.

1.6 PRE-INSTALLATION MEETINGS

- A. Pre-installation Meeting: Conduct meeting at Project Site, Manufacturer's Facility of Fabricator's Shop. Confirm with Owner and Landscape Architect 14 days prior to conference.
 - 1. Before submitting submittals, review submittals, mockup and other requirements of this section and examine procedures for ensuring quality of the scope herein. Require representatives of each entity directly concerned with the scope herein, including but not limited to, the following:
 - a. Contractor's superintendent.
 - b. Subcontractor.
 - c. Special Subcontractor.
 - d. Independent testing agency responsible for testing.
 - e. Product manufacturer and/or local representative.
 - f. Authority Having Jurisdiction.
 - g. Landscape Architect.
 - 2. Review methods and procedures related to the work of this section, including but not limited to, the following:
 - a. Responsibilities of each party.
 - b. Coordination of Landscape Architect's review of the work, including but not limited to:
 - 1) Site or Shop Visits to Review Samples and Mockups
 - 2) Site Visits to Observe General Construction Progress
 - 3) Site or Shop Visits to Review Fabrication Progress
 - 4) Site Visits to Review First Work In Place
 - 5) Site Visits for Punch List Review
 - 6) Site Visits for Punch List Completion Review
 - 7) Site Visit for Warranty Review
 - c. Lines of authority and communication for the project. Procedures for resolution of any project document ambiguity.
 - d. Methods for documenting, reporting, and distributing documents and reports.
 - e. Proposed sources of materials.
 - f. Procedures for packaging and storing archive samples.
 - g. Review of the time schedule for all installation and testing. Schedule of workdays and/or starting times if third party testing verification is required.
 - h. Quality control.

- i. Temperature and weather limitations. Installation procedures for adverse weather conditions. Defining acceptable subgrade or ambient moisture and temperature conditions for working during installation.
- j. Subgrade conditions, dewatering responsibilities, and subgrade maintenance plan.
- k. Deployment techniques including allowable subgrade conditions.
- l. Construction, material placement, and backfilling.
- m. Requirements for protecting work, including restriction of traffic and adjacent work impacting during installation period and for remainder of construction period.
- n. Measurement and payment schedules.
- o. Health and safety.
- p. Procedures and responsibilities for preparation and submission of as-built drawings.

1.7 COORDINATION

- A. Refer to Division 1 Requirements.

1.8 ACTION SUBMITTALS

- A. Product Data: For each type of product submit the following:
 1. Manufacturer's Product Literature and Specification Data.
 2. Manufacturer's written instructions for recommended maintenance practices.
 3. Color and finish samples for verification and selection.
 4. Written manufacturer's warranty.
 5. Product liability insurance certificate with project owner as certificate holder.
 6. MSDS for items in Part 2 "Products."
- B. Samples for Verification: For each type of selection made above provide a final sample.
- C. Shop Drawings: Prepared by or under the supervision of a qualified professional, detailing fabrication and assembly.
 1. Submit shop drawings within a reasonable time so as not to delay the start of material fabrication and installation.
 2. Submit shop drawings per above allowing a minimum review time of 10 business days for review and response. Per above, also allow enough time for revisions and resubmittal where reasonably predictable.
 3. Shop drawings shall show the proposed layout identifying all components and details based on field verified conditions and measurements.
- D. Certifications:
 1. The Contractor shall provide the Engineer a certificate stating the name of the geotextile manufacturer, product name, style, chemical compositions of filaments or yarns and other pertinent information to fully describe the geotextile.

2. The Manufacturer shall demonstrate transparency of their manufacturing process by showing traceability of the product from origin of raw material through finished good.
3. The Manufacturer is responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. Documentation describing the quality control program shall be made available upon request.
4. The manufacturer's certificate shall state that the furnished geotextile meets MARV requirements of the specification as evaluated under the manufacturer's quality control program. The certificate shall be attested to by a person having legal authority to bind the Manufacturer.

1.9 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and Manufacturer.
- B. Material Certificates: For each of the following, signed by manufacturers:
 1. For all materials.
- C. Material Test Reports: For the following, from a qualified testing agency:
 1. For all materials.
 2. Manufacturing Quality Control (MQC) test results shall be provided upon request.
- D. Preconstruction test reports.
- E. Source quality-control test reports.
 - A. Field quality-control and special inspection reports.
 - B. Minutes of pre-installation conference.
 - C. Maintenance Instructions.
 - D. Warranty: Written manufacturer's warranty.

1.10 CLOSEOUT SUBMITTALS

- A. Maintenance Data.

1.11 QUALITY ASSURANCE

- A. Contractor shall establish and maintain a quality assurance program for the purposes of managing the quality of the work. Quality assurance program shall consist of plans, procedures and organizational design necessary to ensure that work of this Section meets the prescriptive and performance requirements specified. The Quality Control, Source Quality Control and Site

Quality Control provisions specified elsewhere in this Section shall form part of the Quality Assurance Program.

- B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Authorities Having Jurisdiction for all work included in this section.
1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.
- C. Codes and Standards: Conform work to all applicable codes and standards.
- D. Manufacturer Qualifications: Provide manufacturer qualifications as follows:
1. Submit a list of ten completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.
 2. Submit qualifications of manufacturer.
 3. Submit manufacturer's quality control program.
 4. Submit example of Material Warranty and any other applicable warranties.
 5. The geotextile Manufacturer shall have all the following credentials:
 - a. ISO 9001:2008 Quality Management System
 - b. Geosynthetic Accreditation Institute (GAI) Laboratory Accreditation Program (LAP)
 6. The geotextile Manufacturer shall have a GAI-LAP accredited laboratory at the location of production capable of performing the ASTM tests as outlined in the specification.
- E. Installer Qualifications: Provide installer qualifications as follows:
1. Submit a list of ten completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.
 2. Submit resumes and/or qualifications of installation manager(s).
 3. Submit fabrication quality control program.
 4. Submit installation quality control program.
 5. Submit example of Material Warranty and any other applicable warranties.
- F. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified for testing indicated. Provide testing agency qualification as follows:
1. Submit a list of ten completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.
 2. Submit resumes and/or qualifications of testing manager(s).
 3. Submit testing quality control program.
 4. Submit example of Material Warranty and any other applicable warranties.
- G. Geotextile:

1. Geotextiles shall be subject to sampling and testing to verify conformance with this specification. Sampling for testing shall be in accordance with ASTM D 4354.
2. Acceptance shall be in accordance with ASTM D 4759 based on testing of either conformance samples obtained using Procedure A of ASTM D 4354, or based on manufacturer's certifications and testing of quality control samples obtained using Procedure B of ASTM D 4354.

H. Product Marking

1. All geotextile products shall be printed at a minimum frequency of once per every 5 meters.
2. Printing shall include:
 - a. Name of source manufacturing facility
 - b. Geotextile product name as listed with AASHTO/NTPEP
 - c. AASHTO M288 class(es) that product meets
3. Additionally, labels should be affixed to the exterior of the packaged roll to include:
 - a. Name of source manufacturing facility
 - b. Geotextile product name as listed with AASHTO/NTPEP
 - c. AASHTO M288 class(es) that product meets
 - d. Date of manufacture

I. Quality Control Testing

1. All supplied geotextiles shall be tested for quality control in a tested laboratory accredited through the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP)
2. All supplied geotextiles shall include certificates of analysis for all specified properties.
3. All testing laboratories shall maintain Quality Management Systems (QMS) certified compliant to the AASHTO/GTX Work Plan for Evaluation of Geotextile Materials for Highway Applications
4. Testing laboratories shall be compliant and certified to the ISO 9001:2008 quality system standard.

J. Manufacturing Facilities

1. The source manufacturing facility for supplied geotextiles shall maintain audited compliance through AASHTO representative auditors for Quality Management System Processes for:
 - a. Organization and Organizational Policies
 - b. Product Marking and Labeling
 - c. Manufacturing Process and Documentation Control
 - d. Quality Control of Raw Materials
 - e. Quality Control Inspection, Measurement, and Testing for Geotextile Products
 - f. Quality Control Personnel – Training and Competency Evaluation
 - g. Statistical Analysis of Test Results
 - h. Resolution of Non-Conforming Product of Test Results
 - i. Retention of Test Results and Product Traceability
 - j. Quality Control Testing Facilities
 - k. Marking, Storage, Shipping, and Handling of Finished Geotextile

1. Internal Quality Audits of Each Plant Producing Product
2. Source manufacturing facilities shall be compliant and certified to the ISO 9001:2008 quality system standard
3. All manufacturing facilities shall be located within the United States or US territories.

K. Sewn Seams (if required):

1. For seams that are to be sewn in the field, the Contractor shall provide at least a 2 meter (6 ft) length of sewn seam for sampling by the Engineer before the geotextile is installed.
2. For seams that are sewn in the factory, the Engineer shall obtain samples of the factory seams at random from and roll of geotextile that is to be used on the project.
3. If seams are to be sewn in both directions, samples of seams from both directions shall be provided.
4. For seams that are field sewn, the seams sewn for sampling shall be sewn using the same equipment and procedures as will be used for the production seams.
5. The seam assembly description shall be submitted by the Contractor along with the sample of the seam. The description shall include the seam type, sewing thread, and stitch density.

L. Sewing Thread (if required)

1. Sewing thread shall consist of high strength polypropylene or polyester (Nylon shall not be used).
2. The thread shall be of a contrasting color to the geotextile.

1.12 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform all required preconstruction testing.

1.13 SEQUENCING AND SCHEDULING

- A. General: Prior to the start of Work, prepare a detailed schedule of the work for coordination with other trades.
- B. Schedule all utility installations prior to beginning work in this section.

1.14 DELIVERY, STORAGE AND HANDLING

- A. Deliver packaged products in an undamaged condition in original containers, displaying manufacturer's labels, along with instructions for handling, storing, unpacking, protecting, and installing.
- B. Deliver and store materials in manufacturer's original containers, with seals unbroken and identification labels intact until time of use.

- C. Deliver products to achieve the shortest duration of storage time as practicable.
- D. Deliver all chemical products in original, unopened containers with original labels intact and legible, which state the guaranteed chemical analysis. Store all chemicals in weather protected enclosure.
- E. Comply with manufacturer's written instructions for delivery, storage, and handling, and as required to prevent damage to products and work during construction.
- F. Store products and materials in a neat and orderly manner. Maintain clear aisles and access to work areas. Protect stored products from theft and damage. Store products above ground in weathertight, ventilated packaging or enclosures.
- G. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.
- H. Store liquids in tightly closed containers protected from freezing.
- I. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- J. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk materials with appropriate certificates.
- K. Geotextile labeling, shipment and storage shall follow ASTM D 4873.
- L. Product labels shall clearly show the manufacturer or supplier name, style name, and roll number.
- M. Each shipping document shall include a notation certifying that the material is in accordance with the manufacturer's certificate.
- N. Each geotextile roll shall be wrapped with a material that will protect the geotextile from damage due to shipment, water, sunlight, and contaminants.
- O. The protective wrapping shall be maintained during periods of shipment and storage. If the wrapping is damaged prior to installation, the outer wrap of geotextile material must be discarded before installation.
- P. During storage, geotextile rolls shall be elevated off the ground and adequately covered to protect them from the following: Site construction damage, extended exposure to ultraviolet

(UV) radiation, precipitation, chemicals that are strong acids or strong bases, flames, sparks, temperatures in excess of 71 deg C (160 deg F) and any other environmental condition that might damage the geotextile.

1.15 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of all site elements and other construction contiguous with the work of this section prior to fabrication and/or installation.
- B. The work shall not occur in the presence of standing water, mud, snow, or frozen subgrade conditions. Work shall not occur while precipitation is occurring or during excessive winds, or when temperatures are outside the limits specified in this specification. Work completed during these conditions will be rejected.
- C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
- D. Hot-Weather Requirements: Comply with hot-weather construction requirements.

1.16 EXCAVATING AND GRADING AROUND UTILITIES

- A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.
- B. Determine location of underground utilities and perform work in a manner that will avoid damage. Hand excavate as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.
- C. Notification of the utility locate services is required for all Excavation and grading deeper than 12 inches: The Contractor is responsible for knowing the location and avoiding utilities that are not covered by the local utility locator service.

1.17 OBSERVATION OF THE WORK

- A. The Landscape Architect may observe the work at any time. They may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting specifications shall be paid by the Contractor.
- B. The Landscape Architect shall be informed of the progress of the work so the work may be observed during key times in the construction process. The Landscape Architect shall be afforded sufficient time to schedule visits to the site. Failure of the Landscape Architect to make field observations shall not relieve the Contractor from meeting all the requirements of this specification.

1.18 FIRST WORK IN PLACE

- A. The Landscape Architect shall be informed once the first work in place has been completed for all individual elements included in this section for review to ensure the work is proceeding in accordance with the approved samples and mockups and per the Contract Documents. The Landscape Architect shall be afforded sufficient time to schedule visits to the site for review. In the event that sufficient time cannot be provided the Contractor shall provide images from multiple angles and perspectives of the work for Landscape Architect review.

1.19 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering and wear.
 - b. Separation or delamination of materials and components.
 2. Warranty Period: One years from date of Substantial Completion.

1.20 MAINTENANCE SERVICE

- A. Contractor to provide standard industry maintenance on all scope items herein until Final Acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. US Fabrics, Inc. (or approved equal)
3904 Virginia Avenue
Cincinnati, OH 45227
(800) 518-2290 Phone
(513) 271-4420 Fax
info@usfabrics.com

2.2 MATERIALS

- A. Geotextile:
1. The geotextile with identification yarns and super high-tenacity polypropylene yarns with a weave pattern to maximize strength, water flow, soil interaction and soil retention. The yarns shall be from high-tenacity long-chain synthetic polymers composed of at least 95 percent by weight of polyolefins or polyesters. They shall form a stable network such

that the filaments or yarns retain their dimensional stability relative to each other, including selvages.

2. All geotextile products shall have a separation factor of 0.9 or higher per ASTM D422, Modified.
3. Approved geotextiles are as follows:
 - a. Separation Geotextile, between base courses (Subgrade CBR \geq 3):
 - 1) Product: US 100NW, or approved equal.
 - b. Separation Geotextile, between base course and subgrade (Subgrade CBR \geq 3):
 - 1) Product: US 160NW, or approved equal.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Prior to installation examine site to confirm that existing conditions are satisfactory for the work of this section to proceed.
- B. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope toward the under drain lines as shown on the drawings.
- C. Confirm that no adverse drainage conditions are present.
- D. Confirm that no conditions are present which are detrimental to plant growth.
- E. Confirm that utility work has been completed per the drawings.
- F. If unsatisfactory conditions are encountered, notify the Landscape Architect immediately to determine corrective action prior to proceeding.

3.2 PREPARATION

- A. Clear, grub, and excavate/fill installation site to design grade. Remove topsoil, vegetation, and other unsuitable materials.
- B. Soft spots and unsuitable areas shall be identified during site preparation or subsequent proof rolling. These areas shall be excavated and backfilled with select materials and compacted using normal procedures.

3.3 COORDINATION WITH PROJECT WORK

- A. The Contractor is responsible for investigating, and being aware of, the work requirements of their sub-contractors and other contractors. The Contractor shall coordinate with all other work that may impact the completion of the work herein.
- B. Prior to the start of work, prepare a detailed schedule of the work for coordination with other trades.

3.4 INSTALLATION

- A. The geotextile shall be laid smooth without wrinkles or folds on the prepared subgrade in the direction of construction traffic.
- B. Adjacent geotextiles rolls shall be overlapped, sewn or joined as required below:

Subgrade CBR	Minimum Overlap
Greater than 3	300 - 450 mm (12 - 18 in)
1 - 3	600 - 1000 mm (24 - 36 in)
0.5 - 1	1000 mm (36 in) or sewn
Less than 0.5	Sewn
All roll ends	1000 mm (36 in) or sewn

- C. When sewn seams are required, the seam strength, as measured by ASTM D4632 shall be equal to or greater than 90 percent of the specified grab strength.
- D. On curves, the geotextile may be folded or cut to conform to the curves. The fold or overlap shall be in the direction of construction and held in place by pins, staples, or piles of fill or rock.
- E. Prior to covering, the geotextile shall be inspected by a certified inspector of the Engineer to ensure that it has not been damaged during installation.
- F. Damaged areas, as identified by the Engineer, shall be repaired immediately by covering the damaged area with a geotextile patch that extends an amount equal to the required overlap beyond the damaged area.
- G. The subbase shall be placed by end dumping onto the geotextile, or over previously placed subbase aggregate such that at least the minimum specified lift thickness shall be between the construction equipment tires or tracks and the geotextile at all times.
- H. Pretensioning Geotextile:

1. Proof roll with heavily loaded, rubber-tired vehicle. Wheel load of truck shall be equivalent to maximum expected for site. Vehicle to make at least four passes over first lift in each area of site.
 2. Once design aggregate has been placed, use roadway prior to paving to prestress geotextile-aggregate system in key areas.
 - I. If required, staple or pin geotextile at overlaps to maintain position during construction activities. Use 250 to 300 mm (10 to 12 in) long nails placed at minimum 15 m (50 ft) on center for parallel rolls and 1.5 m (5 ft) on center for roll ends.
 - J. Do not place overlaps along anticipated primary wheel path locations. Place overlaps at end of rolls in direction of aggregate placement with previous roll on top.
 - K. When geotextile intersects an existing pavement area, extend geotextile to edge of old system. For widening or intersecting existing roads where geotextiles have been used, anchor geotextile at roadway edge.
 - L. Compact first lift of base aggregate with a tracking dozer and then compact with smooth-drum vibratory roller to obtain minimum compacted density.
 - M. Compaction of permeable bases shall meet specified requirements.
 - N. Perform construction parallel to road alignment.
 - O. Fill ruts formed during construction to maintain adequate cover over geotextile. Do not blade ruts down.
 - P. Place remaining base aggregate in lifts not exceeding 250 mm (10 in) in loose thickness and compact to specified density.
- 3.5 GRADE, ELEVATION AND ALIGNMENT CONTROL
- A. Provide grade and elevation control during installation of the work of this section. Utilize grade stakes, string lines, surveying equipment, and other means and methods to assure that grades and contours conform to the grades indicated on the plans.
 - B. Provide alignment control during installation of the work of this section. Utilize stakes, pins, marking techniques, string lines, surveying equipment, and other means and methods to assure that alignments conform to the alignments on the plans.
- 3.6 REPAIR AND REPLACEMENT
- A. General: Repair or replace that is damaged by construction operations, in a manner approved by Landscape Architect.

3.7 WASTE HANDLING

- A. General: Handle waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

3.8 CLEANING

- A. The contractor should clean the job site and remove any excess materials. Coordinate with Owner for storage locations for any Attic Stock materials where applicable.

3.9 PROTECTION

- A. Atmospheric exposure of the geotextile to the elements following laydown shall be limited to 14 days to prevent damage.
- B. Equipment may operate on roadway without aggregate for geotextile installation under permeable bases if subgrade is of sufficient strength.
 - 1. For extremely soft soils, use lightweight construction vehicles for access on first lift.
 - 2. Limit construction vehicles in size and weight to limit rutting in initial lift to 75 mm (3 in).
 - 3. If rut depths exceed 75 mm (3 in), decrease construction vehicle size or weight or increase lift thickness.
- C. Turning not permitted on first lift of base aggregate. Construct turnouts at roadway edge to facilitate construction.

3.10 MAINTENANCE SERVICE

- A. Maintenance Service: Provide maintenance by skilled employees of Installer or approved Subcontractor. Maintain as required in "Maintenance" Article. Begin maintenance immediately after scope is installed and continue until final acceptance.

3.11 DEMONSTRATION AND TRAINING

- A. Engage a manufacturer-authorized service representative and/or other authorized professional to train Owner's maintenance personnel to adjust and operate all components herein.
- B. Train Owner's maintenance personnel in proper maintenance procedures for all components herein.

END OF SECTION - 31 32 19

SECTION 32 1216 - HOT MIX ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes hot mix asphalt paving as shown on the Drawings and as specified herein.

1.2 SUBMITTALS

- A. Product Data: For each type of product specified. Include technical data and tested physical and performance properties.
- B. Job-Mix Designs: For each job mix proposed for the Work.
 - 1. Job-mix design documentation shall include the amount of RAP material, by percentage of total mix, to be utilized.
 - 2. Job-mix design documentation shall clearly indicate source/origin of RAP material.
- C. Qualification Data: For IDOT qualified manufacturer and Installer.
- D. Material Certificates: For each paving material, from manufacturer.
- E. Material Test Reports: For each paving material and mix.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Illinois Department of Transportation (IDOT) construction guides and manuals as described, specified, and illustrated in the current edition of the "Standard Specifications for Road and Bridge Construction," including Supplemental Specifications and Recurring Special Provisions, latest editions and updates for asphalt paving work. Hereafter these documents are referenced as the "IDOT Standard Specifications, (IDOT SSRBC)".
 - 1. Measurement and payment provisions and safety program submittals included in IDOT Standard Specifications do not apply to this Section.
- B. Manufacturer Qualifications: Hot mix asphalt manufacturer shall have valid and current IDOT approvals for materials and work specified.
- C. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:
 - a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.

- b. Review condition of subgrade and preparatory work.
- c. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
- d. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

1.4 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met. Temperatures are to be taken in the shade, away from exposed pavement and stone aggregate fill and other artificial heat sources.
 - 1. Prime Coat: Minimum surface temperature of 60 deg F.
 - 2. Slurry Coat: Comply with weather limitations in ASTM D 3910.
 - 3. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
 - 4. Asphalt Binder Course: Minimum surface temperature of 40 deg F and rising at time of placement.
 - 5. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

PART 2 - PRODUCTS

2.1 PAVING MATERIALS

- A. Granular Base Course: Complying with requirements of IDOT Standard Specifications, Section 311, for type B base course with gradation CA-6 crushed stone.
- B. Hot Mix Asphalt Binders, Surface Courses and Materials: Complying with IDOT Standard Specifications, Section 1030, Class I.
 - 1. Parking Area:
 - a. See drawings.
 - 2. Street Restoration:
 - a. Per City of Evanston requirements and specifications.
 - 3. Reclaimed Asphalt Pavement (RAP): RAP, complying with IDOT Standard Specifications, may be used only when approved in writing by the Architect of Record prior to starting the Work.
 - a. No more than 25% of the proposed asphalt mix is allowed to be RAP material.
 - b. RAP material shall be free of contamination, including, but not limited to, dirt, sand, brick, debris, concrete, sheet asphalt, sealant materials, and clean stone.

2.2 AUXILIARY MATERIALS

- A. Herbicide: Commercial chemical for weed control, registered by the Environmental Protection Agency (EPA). Provide in granular, liquid, or wettable powder form.
- B. Sand: ASTM D 1073, Grade Nos. 2 or 3.
- C. Paving Geotextile: AASHTO M 288, nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.
- D. Joint Sealant: ASTM D 6690, Type II or III, hot-applied, single-component, polymer-modified bituminous sealant.
- E. Pavement marking: All pavement marking indicated on plans shall be thermoplastic and conform to IDOT SSRBC 2020 requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to begin paving.
- B. Proceed with paving only after unsatisfactory conditions have been corrected.
- C. Commencement of asphalt paving work will be an indication of the acceptance of sub-grade and the Contractor will be held responsible for the satisfactory execution and results of the finished work.

3.2 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Verify that prepared subgrade is ready to receive paving.
- B. Subgrade: Shall comply with requirements of IDOT Standard Specifications, Section 301. Subgrade shall be proof-rolled in accordance with Division 31 Section "Earthwork for Sitework."
- C. Herbicide Treatment: Where required or as directed by Project Engineer or Architect, apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted aggregate base before applying paving materials.
 - 1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.
- D. Tack Coat: Apply uniformly to existing pavement surfaces at a rate of 0.05 - 0.10 gal./sq. yd.
 - 1. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

2. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 3. Prohibit traffic across tack coat for period not less than that required by manufacturer.
- E. Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.25 - 0.50 gal. / sq. yd. Apply enough material to penetrate and seal but not flood surface. Allow prime coat to cure fully.
1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
 2. Protect primed substrate from damage until ready to receive paving.

3.3 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt paving on prepared surfaces, spread uniformly, and strike off, in accordance with IDOT Standard Specifications, Sections 406 and 407. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
 2. Place hot-mix asphalt surface coat in single lift.
 3. Spread mix at minimum temperature of 250 deg F.
 4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
 5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.4 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course. Joints between successive days' work shall be constructed to ensure thorough and continuous bond between the newly and previously placed paving.
1. Clean contact surfaces and apply tack coat to joints.
 2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
 3. Offset transverse joints, in successive courses, a minimum of 24 inches.

4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to the Asphalt Institute MS-22, "Construction of Hot-Mix Asphalt Pavements," for both "Ending a Lane" and "Resumption of Paving Operations."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within two percent (2%) of specified course density.

3.5 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
 1. Complete compaction before mix temperature cools to 185 deg F.
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
 1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- G. Frames of subsurface structures:
 1. Coat surfaces of new and existing frames with oil to prevent bond with asphalt paving.
 2. Set cover rings to be flush with finish surface and surround with a ring of compacted asphaltic concrete to one inch below top of frame. Adjust as required to meet paving.
 3. Provide temporary covers over openings until completion of rolling operations
- H. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and sufficiently hardened, as determined by the Project Engineer.

- I. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.6 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 1. Base Course: Plus or minus 1/2-inch.
 2. Binder Course: Plus or minus 1/4-inch.
 3. Surface Course: Plus 1/4- inch, no minus.
- B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot long straightedge applied transversely or longitudinally to paved areas:
 1. Base Course: 1/2-inch.
 2. Binder Course: Plus or minus 1/4-inch.
 3. Surface Course: 1/8-inch.
 4. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4-inch.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: The Owner will engage a qualified testing agency to perform tests and inspections.
- B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.
- C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979.
 1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
 2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
 - a. Take one core sample for every 1,000 square yards or less of installed pavement, with no fewer than three (3) core samples taken.
 - b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
- E. Replace and compact hot-mix asphalt where core tests were taken.

- F. Remove and replace and/or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.8 DISPOSAL

- A. Except for material indicated to be recycled, all rubbish and debris resulting from the Work of this Section must be collected, removed from the site, and disposed of legally in an approved landfill.

END OF SECTION

SECTION 32 1313 - PORTLAND CEMENT CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes Portland cement concrete paving required to complete the project.

1.2 SUBMITTALS

- A. Laboratory Test Reports: Submit 2 copies of laboratory test reports to concrete materials and mix design tests.
- B. Delivery Tickets: Submit copies of delivery tickets for each load of concrete delivered to the site.
- C. Product Data: Submit copies of manufacturer's specifications with application and installation instructions for proprietary materials and items upon request.

1.3 QUALITY ASSURANCE

- A. Perform work in accord with IDOT Standard Specifications for Road and Bridge Construction (SSRBC), current edition and all addenda.
- B. Obtain materials from same source throughout.
- C. Regulatory Requirements:
 - 1. Illinois Steel Products Procurement Act as amended (Illinois Revised Statutes, Ch. 48, par. 1901 et. seq.).
- D. Mock-Up:
 - 1. Samples Panel:
 - a. General Contractor: Before installing any exterior concrete paving, provide a sample paving panel for a typical concrete walk inclusive of a handicapped curb ramp.
 - b. Paving is to show the proposed color, surface finish of both the walk and textured ramp surface, reinforcement, control and expansion joints, sealant and workmanship.
 - c. Panel size shall be a minimum of 5' -0" wide x 15' -0" long in the presence of the Architect prior to the installation of these materials on the site.
 - d. Erect the panel in a location acceptable to the Architect and in the presence of the Architect prior to the installation of these materials on the site.

- e. Do not start concrete site work until the Architect has given written approval of all components of the sample panel.
- f. This sample panel will be used as a standard of comparison for all site concrete constructed of same materials.

E. Concrete Testing Service:

- 1. The Owner will employ a separate testing laboratory to perform initial field quality control testing.
- 2. Materials and installed Work may require testing and retesting at any time during the progress of the Work. Allow free access to material stockpiles and facilities at all times. Retesting of rejected materials and installed Work shall be done at the Contractor's expense.
- 3. Three concrete test cylinders shall be taken for every 75 or less cu. yds. of each class of concrete placed each day.
- 4. One additional test cylinder shall be taken during cold weather and be cured on site under same conditions as concrete it represents.
- 5. One slump test shall be taken for each set of test cylinders taken.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

- A. Comply with IDOT Specification, Article 803.04.

2.2 REINFORCEMENT

- A. Reinforcing steel: ASTM A 615: Grade 60, epoxy coated.
- B. Welded steel wire fabric: Plain type, ASTM A 185; rolls; epoxy coated.
- C. Tie wire: Annealed steel, minimum 16 gauge size.
- D. Dowels: ASTM A 615; Grade 40, plain steel, epoxy coated.

2.3 ACCESSORIES

- A. Curing compound: Comply with IDOT Specification, Article 718.04. Also see Part 3.09 Curing.
- B. Liquid surface sealer. ASTM D 3405.
- C. Preformed joint filler: ASTM D 1751.

2.4 ADMIXTURES

- A. Air entrainment admixture: Comply with ASTM C 260.
- B. Chemical admixture: Comply with ASTM C 94.

2.5 CONCRETE MATERIALS

- A. Color Pigment: S-12 Cold Front Gray Cement, SRI 25 and SR 0.240
 - 1. Manufacturer: Sika Corporation, 4155 Scofield Rd., Douglasville, GA 30134, Phone: (800) 800-9900, Website: www.scofield.com (or approved equal)
 - a. Model No: SOLACHROME™ High SR Color

2.6 CONCRETE MIX

- A. Mix concrete in accordance with IDOT SSRBC, current edition, Section 1020, for Class PV Type III Concrete. Also mix in accordance with Section 1020.11.
- B. Provide concrete for paving of the following characteristics:
 - 1. Compressive strength:
 - a. At 14 days: 3500 psi.
- C. Use accelerating admixtures in cold weather only with Architect prior written approval. Use of admixtures will not relax cold weather placement requirements.
- D. Add air entraining agent to concrete mix for concrete work subject to freeze/thaw cycling and exposed to exterior.
- E. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

PART 3 - EXECUTION

3.1 SUBGRADE PREPARATION

- A. Prepare in accordance with IDOT SSRBC, current edition, Section 301.
 - 1. Proof roll areas under drives and parking areas.
- B. Provide additional fill for soft spots and hollows.
- C. Level and Compact subgrade, to receive granular base for concrete work, to 95% Modified Proctor Density.

3.2 CONCRETE PLACING

- A. Place all paving concrete in accordance with IDOT SSRBC, current edition, Section 420.
- B. Place concrete for sidewalks in accordance with IDOT SSRBC, current edition, Section 424.
- C. Cure concrete in accordance with IDOT SSRBC, current edition, Section 420.

3.3 INSPECTION

- A. The Testing Laboratory shall verify that the compacted base is ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.
- C. Start of installation constitutes acceptance of existing conditions.

3.4 PREPARATION

- A. Moisten base to minimize absorption of water from fresh concrete.
- B. Notify Architect minimum 48 hours before start of concreting operations.

3.5 FORMING

- A. Place and secure forms to correct location, dimensions and profile.
- B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
- C. Place joint fillers vertical in position, in straight lines. Secure to formwork during concrete placement.

3.6 REINFORCEMENT

- A. Place reinforcement at mid-height of slabs-on-grade.
- B. Interrupt reinforcement at contraction and expansion joints.
- C. Place reinforcement to achieve slab and curb alignment as detailed.
- D. Provide dowelled joints at interruptions of concrete with one end of dowel set in capped sleeve to allow longitudinal movement.

3.7 FORMED JOINTS

- A. Place expansion, control and contraction joints as shown on the drawings. Align curb, gutter and sidewalk joints.

- B. All expansion joints in concrete paving, sidewalk paving, and curb shall be sealed per IDOT SSRBC, current edition.
- C. Place joint filler between paving components and building (s) or other appurtenances. Recess top of filler 1/2 inch for sealer placement.
- D. Provide scored, joints at 5 feet intervals of sidewalk except where otherwise shown.

3.8 CURING

- A. Curing and protection shall be as outlined in IDOT SSRBC, current edition, Section 1022. Color lithochrome color wax matching the colored concrete as manufactured by L.M. Schofield Company or approved equal, and applied in accordance with the manufacturer's written instructions; or white pigmented curing compound as outlined in IDOT SSRBC, current edition, Section 1022 are the preferred curing methods. White-opaque polyethylene film shall not be accepted as a curing method.

3.9 FINISHING

- A. Area paving: Light broom finish shall be perpendicular to the path of travel, radiused and trowel joint edges, wood float.
- B. Sidewalk paving: Light broom finish shall be perpendicular to the path of travel, radiused and trowel joint edges, wood float.
- C. Vehicular paving: Medium broom finish shall be perpendicular to the path of travel, radiused and trowel joint edges, wood float.
- D. Curbs and gutters: Light broom.
- E. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's current printed instructions.

3.10 PROTECTION

- A. Immediately after placement, protect concrete from premature drying, excessive hot or cold temperatures and mechanical injury. Maintain protection until accepted.

3.11 FIELD QUALITY CONTROL

- A. Maintain record of placed concrete items. Record date, location of pour, quantity, air temperature and test samples taken.
- B. Initial Testing: The Owner will employ a separate testing laboratory to perform field quality control testing.
- C. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate the specified concrete strengths and other characteristics have not been attained

in the structure, as directed by the Architect. The Contractor shall pay for such tests conducted, and any other additional testing as may be required, when unacceptable concrete is verified.

D. Formed Concrete Dimensional Tolerances:

1. Formed concrete having any dimension smaller or greater than required, and outside the specified tolerance limits, will be considered deficient in strength and subject to additional testing as herein specified.
2. Formed concrete having any dimension greater than required will be rejected if the appearance or function of the structure is adversely affected, or if the larger dimensions interfere with other construction. Repair, or remove and replace rejected concrete as required to meet the construction conditions. When permitted, accomplish the removal of excessive material in a manner to maintain the strength of the section without affecting function and appearance.
3. Construction for ADAAG accessible walks, pavement surfaces, and areas shall have tolerance limits in accordance with local and federal regulations (whichever is more stringent).

- E. Defective Work: Concrete work which does not conform to the specified requirements, including strength, tolerances, and finishes, shall be corrected at the Contractor's expense, without extension of time therefore. The Contractor shall also be responsible for the cost of corrections to any other work affected by or resulting from corrections to the concrete work.

END OF SECTION

SECTION 32 13 14 - ARTIFICIAL TURF

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes synthetic grass surfacing.
- B. Related Requirements:
 - 1. Section 03 30 00.01 "Cast-In-Place Concrete" for related attachments and curbs.

1.3 PRE-INSTALLATION MEETINGS

- A. Pre-installation Meeting: Conduct meeting at Project Site, Manufacturer's Facility of Fabricator's Shop. Confirm with Owner and Landscape Architect 14 days prior to conference.
 - 1. Before submitting submittals, review submittals, mockup and other requirements of this section and examine procedures for ensuring quality of the scope herein. Require representatives of each entity directly concerned with the scope herein, including but not limited to, the following:
 - a. Contractor's superintendent.
 - b. Subcontractor.
 - c. Special Subcontractor.
 - d. Product manufacturer and/or local representative.
 - e. Landscape Architect.
 - 2. Review methods and procedures related to the work of this section, including but not limited to, the following:
 - a. Responsibilities of each party.
 - b. Coordination of Landscape Architect's review of the work, including but not limited to:
 - 1) Site or Shop Visits to Review Samples and Mockups
 - 2) Site Visits to Observe General Construction Progress
 - 3) Site or Shop Visits to Review Fabrication Progress
 - 4) Site Visits to Review First Work In Place
 - 5) Site Visits for Punch List Review
 - 6) Site Visits for Punch List Completion Review

- c. Lines of authority and communication for the project. Procedures for resolution of any project document ambiguity.
- d. Methods for documenting, reporting, and distributing documents and reports.
- e. Proposed sources of materials.
- f. Procedures for packaging and storing archive samples.
- g. Review of the time schedule for all installation.
- h. Quality control.
- i. Temperature and weather limitations. Installation procedures for adverse weather conditions. Defining acceptable subgrade or ambient moisture and temperature conditions for working during installation.
- j. Subgrade conditions, dewatering responsibilities, and subgrade maintenance plan.
- k. Deployment techniques including allowable subgrade conditions.
- l. Construction, material placement, and backfilling.
- m. Requirements for protecting work, including restriction of traffic and adjacent work impacting during installation period and for remainder of construction period.
- n. Health and safety.
- o. Procedures and responsibilities for preparation and submission of as-built drawings.

1.4 COORDINATION

- A. Refer to Division 1 Requirements.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product submit the following:
 1. Manufacturer's Product Literature and Specification Data.
 2. Manufacturer's written instructions for recommended maintenance practices.
 3. Color and finish samples for verification and selection.
 4. Written manufacturer's warranty.
 5. Product liability insurance certificate with project owner as certificate holder.
 6. MSDS for items in Part 2 "Products."
- B. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.
 1. Turf Fabric: 12 inches (300 mm) square.
 2. Infill Material: 4 oz. (100 g) of each type.
 3. Shock-Attenuation Pad: 12 inches (300 mm) square.
 4. Seam Sample: 24 inches (600 mm) square with seam centered in sample.
- C. Samples for Verification: For each type of selection made above provide a final sample.
- D. Shop Drawings: For synthetic grass surfacing.
 1. Include sections and details.

2. Show locations of seams and method of seaming.
3. Show layout of game lines, numbers, and letters. Indicate application method of each line and marking.
4. Show location and layout of team logo/graphics. Submit shop drawings within a reasonable time so as not to delay the start of material fabrication and installation.
5. Submit shop drawings per above allowing a minimum review time of 10 business days for review and response. Per above, also allow enough time for revisions and resubmittal where reasonably predictable.
6. Shop drawings shall show the proposed layout identifying all components and details based on field verified conditions and measurements.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, Fabricator, Manufacturer.
- B. Material Certificates: For each of the following, signed by manufacturers:
 1. For all materials.
- C. Material Test Reports: For the following, from a qualified testing agency:
 1. For all materials.
- D. Preconstruction test reports.
- E. Source quality-control test reports.
 - A. Field quality-control and special inspection reports.
 - B. Minutes of pre-installation conference.
 - C. Maintenance Instructions.
 - D. Warranty: Written manufacturer's warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For synthetic grass surfacing, including maintenance cleaning instructions, to include in maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Turf Fabric: Minimum of 300 sq. ft. (28 sq. m) for each type indicated.
 2. Infill: Minimum of two bags of each type.

3. Seaming Tape and Adhesive: One roll of seaming tape and one gallon of adhesive.
4. One new set of maintenance tools, of type recommended by synthetic grass surfacing manufacturer for installation.

1.9 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Authorities Having Jurisdiction for all work included in this section.
 1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.
- B. Codes and Standards: Conform work to all applicable codes and standards.
- C. Manufacturer Qualifications: Provide manufacturer qualifications as follows:
 1. Submit a list of five completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.
 2. Submit example of Material Warranty and any other applicable warranties.
- D. Installer Qualifications: Provide installer qualifications as follows:
 1. Submit a list of five completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.
 2. Submit example of Warranty and any other applicable warranties.
- E. Mockups: Provide mockup for each type of component per the Drawings and/or shop drawing.
 1. Build mockups of full-profile sections to demonstrate including but not limited to overall material quality, typical joints; typical transitions, surface finish, surface texture, color; and standard of workmanship.
 2. Build mockups in the location and of the size indicated. Build mockups where directed by Landscape Architect.
 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Landscape Architect specifically approves such deviations in writing.
 4. Subject to compliance with requirements, approved mockups may not become part of the completed work.
 5. Mockups to be retained on site or at approved location by Owner and Landscape Architect until all related work scope is deemed Substantially Complete.
 6. Contractor to rework mockups as necessary until mockups are accepted.

1.10 DELIVERY, STORAGE AND HANDLING

- A. Deliver packaged products in an undamaged condition in original containers, displaying manufacturer's labels, along with instructions for handling, storing, unpacking, protecting, and installing.
- B. Deliver and store materials in manufacturer's original containers, with seals unbroken and identification labels intact until time of use.
- C. Deliver products to achieve the shortest duration of storage time as practicable.
- D. Deliver all chemical products in original, unopened containers with original labels intact and legible, which state the guaranteed chemical analysis. Store all chemicals in weather protected enclosure.
- E. Comply with manufacturer's written instructions for delivery, storage, and handling, and as required to prevent damage to products and work during construction.
- F. Store products and materials in a neat and orderly manner. Maintain clear aisles and access to work areas. Protect stored products from theft and damage. Store products above ground in weathertight, ventilated packaging or enclosures.
- G. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.
- H. Store liquids in tightly closed containers protected from freezing.
- I. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- J. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk materials with appropriate certificates.
- K. Store materials in location and manner to allow installation of synthetic grass surfacing without excess disturbance of granular base.

1.11 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of all site elements and other construction contiguous with the work of this section prior to fabrication and/or installation.

- B. The work shall not occur in the presence of standing water, mud, snow, or frozen subgrade conditions. Work shall not occur while precipitation is occurring or during excessive winds, or when temperatures are outside the limits specified in this specification. Work completed during these conditions will be rejected.
- C. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements.

1.12 EXCAVATING AND GRADING AROUND UTILITIES

- A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.
- B. Determine location of underground utilities and perform work in a manner that will avoid damage. Hand excavate as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.
- C. Notification of the utility locate services is required for all Excavation and grading deeper than 12 inches: The Contractor is responsible for knowing the location and avoiding utilities that are not covered by the local utility locator service.

1.13 OBSERVATION OF THE WORK

- A. The Landscape Architect may observe the work at any time. They may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting specifications shall be paid by the Contractor.
- B. The Landscape Architect shall be informed of the progress of the work so the work may be observed during key times in the construction process. The Landscape Architect shall be afforded sufficient time to schedule visits to the site. Failure of the Landscape Architect to make field observations shall not relieve the Contractor from meeting all the requirements of this specification.

1.14 FIRST WORK IN PLACE

- A. The Landscape Architect shall be informed once the first work in place has been completed for all individual elements included in this section for review to ensure the work is proceeding in accordance with the approved samples and mockups and per the Contract Documents. The Landscape Architect shall be afforded sufficient time to schedule visits to the site for review. In

the event that sufficient time cannot be provided the Contractor shall provide images from multiple angles and perspectives of the work for Landscape Architect review.

1.15 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace synthetic grass surfacing that fails in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration and excessive wear.
 - b. Deterioration from UV light.
 - c. Excessive loss of shock attenuation.
 - d. Seam separation, including game lines and markings.
 - 2. Warranty Period: 5 years from date of Substantial Completion.

1.16 MAINTENANCE SERVICE

- A. Contractor to provide standard industry maintenance on all scope items herein until Final Acceptance.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Turf Fabric: Turf fabric tested according to the following methods, with additional test method conditions for each method according to ASTM F 1551.
 - 1. Tuft Bind: Not less than 10 lbf (45 N) according to ASTM D 1335.
 - 2. Breaking Strength: Minimum 250 lbf (1112 N) in warp direction and minimum 250 lbf (1112 N) perpendicular to warp direction, according to ASTM D 5034.
- B. Synthetic Grass Surfacing: Assembly tested according to the following methods, with additional test method conditions for each method according to ASTM F 1551.
 - 1. Shock Attenuation: No greater than G(max) at time of installation according to ASTM F 355.
 - 2. Abrasiveness Index: according to ASTM F 1015.
- C. Permeability: in./h (mm/h) of rainfall capacity according to ASTM F 2898 or EN 15330-1.
- D. Durability: Minimum of wear cycles according to EN 15306 (Lisport test).

2.2 SYNTHETIC GRASS SURFACING

- A. Synthetic Grass Surfacing: Complete surfacing system, consisting of synthetic yarns bound to water-permeable backing and infill indicated, suitable for recreational activities.
- B. Turf Fabric: Woven turf fabric with multicolored fiber and UV resistance, complying with the following:
 - 1. Yarn Fiber: Monofilament polyethylene
 - 2. Lead Content of Yarn Fiber: Maximum of 100 ppm according to ASTM F 2765.
 - 3. Pile Weight: according to ASTM D 5848.
 - 4. Pile Height: according to ASTM D 5823.
- C. Backing: Manufacturer's standard woven or nonwoven polypropylene primary backing with urethane-coated secondary backing; provide perforations or drainage channels sufficient to meet permeability indicated.
- D. Infill: Manufacturer's standard sand and rubber infill.
 - 1. Infill Proportions: 70 percent rubber, 30 percent sand.
- E. Game Lines and Markings: Provide game lines and markers in widths and colors according to requirements indicated on Drawings.
 - 1. Application Method: Tufted in to the maximum extent practicable, with remaining lines inlaid.
 - 2. Team Logo/Graphic: Provide inlaid team logo/graphic in colors and design indicated.
- F. Seaming Method: Adhesive.

2.3 MATERIALS

- A. Rubber Infill: Ground latex-coated SBR crumb rubber mesh free of metal, nonmetal fibers, and contaminants; mesh size as recommended by synthetic grass surfacing manufacturer.
- B. Sand Infill: Uniformly sized latex-coated silica sand free of silts, clays, and contaminants, and of subangular or rounder shape according to ASTM F 1632; mesh size as recommended by synthetic grass surfacing manufacturer.
- C. TPO Infill: Uniformly sized TPO granules free of contaminants; particle size as recommended by synthetic grass surfacing manufacturer.
- D. Organic Fiber Infill: Coconut or cork fiber granules free of contaminants, and as recommended by synthetic grass surfacing manufacturer.
- E. Seam Adhesive: One- or two-part urethane, recommended or approved by synthetic grass surfacing manufacturer, and suitable for ambient conditions at time of installation.

- F. Seam Tape: Synthetic grass manufacturer's recommended seam tape, minimum 12 inches (305 mm) wide, 18 inches (457 mm) wide for inlaid game lines.
- G. Seaming Cord: Seaming cord or thread, recommended by the synthetic grass surfacing manufacturer.
- H. Shock-Attenuation Pad: Porous composite consisting of rubber granules bound with urethane adhesive, 12 mm thick; dimpled; with drainage composite laminated to one side. Provide shock-attenuation pad with permeability sufficient to meet synthetic grass surfacing assembly permeability indicated.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Prior to installation examine site to confirm that existing conditions are satisfactory for the work of this section to proceed.
- B. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope toward the under drain lines as shown on the drawings.
- C. Confirm that no adverse drainage conditions are present.
- D. Confirm that no conditions are present which are detrimental to plant growth.
- E. Confirm that utility work has been completed per the drawings.
- F. If unsatisfactory conditions are encountered, notify the Landscape Architect immediately to determine corrective action prior to proceeding.

3.2 EXAMINATION

- A. Examine base and other conditions, with Installer present, for compliance with requirements for installation tolerances, permeability, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 COORDINATION WITH PROJECT WORK

- A. The Contractor is responsible for investigating, and being aware of, the work requirements of their sub-contractors and other contractors. The Contractor shall coordinate with all other work that may impact the completion of the work herein.
- B. Prior to the start of work, prepare a detailed schedule of the work for coordination with other trades.

3.4 INSTALLATION

- A. Avoid disturbance of base during installation of shock-attenuation pad and turf fabric.
- B. Shock-Attenuation Pad Installation: Roll out pad and allow to relax a minimum of six hours prior to final fit and trim. Stagger head seams between adjacent rows. Fit seams snugly without stretching or forcing.
- C. Roll out turf fabric and allow to relax at least four hours prior to seaming.
- D. Provide seams flat and snug, with no gaps or fraying. Remove yarns that are trapped within seams. Attach turf fabric to perimeter restraint system as recommended by the manufacturer.
- E. Repair loose seams and bubbles formed due to expansion of turf fabric prior to installation of infill.
- F. Evenly broadcast and groom infill by machine in proportions and depth after settling as recommended by the manufacturer, and to meet indicated performance requirements. Rake fibers trapped by infill to surface.

3.5 GRADE AND ELEVATION CONTROL

- A. Provide grade and elevation control during installation of the work of this section. Utilize grade stakes, surveying equipment, and other means and methods to assure that grades and contours conform to the grades indicated on the plans.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

3.7 REPAIR AND REPLACEMENT

- A. General: Repair or replace that is damaged by construction operations, in a manner approved by Landscape Architect.

3.8 WASTE HANDLING

- A. General: Handle waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

3.9 CLEANING

- A. The contractor should clean the job site and remove any excess materials. Coordinate with Owner for storage locations for any Attic Stock materials where applicable.

3.10 DEMONSTRATION AND TRAINING

- A. Engage a manufacturer-authorized service representative and/or other authorized professional to train Owner's maintenance personnel to adjust and operate all components herein.
- B. Train Owner's maintenance personnel in proper maintenance procedures for all components herein.
- C. Train Owner's maintenance personnel in proper maintenance procedures for synthetic grass surfacing.

END OF SECTION 32 13 14

SECTION 32 13 73 – CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Cold-applied joint sealants.
 - 2. Joint-sealant backer materials.
 - 3. Primers.
- B. Related Requirements:
 - 1. Section 32 13 13 “Concrete Paving.”

1.3 PERMITS AND FEES

- A. Permits: The Contractor shall secure and pay for all permits, inspections, and certificates of inspection of any governmental and inspection body having jurisdiction over all or any part of the work included under this section and/or such inspections etc., required by these specifications.
- B. Fees: The Contractor shall secure and pay for all fees and assessments in connection with the work under this contract and shall include this cost in its bid and contract price.

1.4 PRE-INSTALLATION MEETINGS

- A. Pre-installation Meeting: Conduct meeting at Project Site, Manufacturer’s Facility of Fabricator’s Shop. Confirm with Owner and Landscape Architect 14 days prior to conference.
 - 1. Before submitting submittals, review submittals, mockup and other requirements of this section and examine procedures for ensuring quality of the scope herein. Require representatives of each entity directly concerned with the scope herein, including but not limited to, the following:
 - a. Contractor's superintendent.
 - b. Subcontractor.
 - c. Special Subcontractor.
 - d. Independent testing agency responsible for testing.

- e. Product manufacturer and/or local representative.
 - f. Authority Having Jurisdiction.
 - g. Landscape Architect.
2. Review methods and procedures related to the work of this section, including but not limited to, the following:
- a. Responsibilities of each party.
 - b. Coordination of Landscape Architect's review of the work, including but not limited to:
 - 1) Site or Shop Visits to Review Samples and Mockups
 - 2) Site Visits to Observe General Construction Progress
 - 3) Site or Shop Visits to Review Fabrication Progress
 - 4) Site Visits to Review First Work In Place
 - 5) Site Visits for Punch List Review
 - 6) Site Visits for Punch List Completion Review
 - 7) Site Visit for Warranty Review
 - c. Lines of authority and communication for the project. Procedures for resolution of any project document ambiguity.
 - d. Methods for documenting, reporting, and distributing documents and reports.
 - e. Proposed sources of materials.
 - f. Procedures for packaging and storing archive samples.
 - g. Review of the time schedule for all installation and testing. Schedule of workdays and/or starting times if third party testing verification is required.
 - h. Quality control.
 - i. Temperature and weather limitations. Installation procedures for adverse weather conditions. Defining acceptable subgrade or ambient moisture and temperature conditions for working during installation.
 - j. Subgrade conditions, dewatering responsibilities, and subgrade maintenance plan.
 - k. Deployment techniques including allowable subgrade conditions.
 - l. Construction, material placement, and backfilling.
 - m. Requirements for protecting work, including restriction of traffic and adjacent work impacting during installation period and for remainder of construction period.
 - n. Measurement and payment schedules.
 - o. Health and safety.
 - p. Procedures and responsibilities for preparation and submission of as-built drawings.

1.5 COORDINATION

- A. Refer to Division 1 Requirements.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product submit the following:
 - 1. Manufacturer's Product Literature and Specification Data.
 - 2. Manufacturer's written instructions for recommended maintenance practices.

3. Color and finish samples for verification and selection.
 4. Written manufacturer's warranty.
 5. Product liability insurance certificate with project owner as certificate holder.
 6. MSDS for items in Part 2 "Products."
- B. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.
- C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Paving-Joint-Sealant Schedule: Include the following information:
1. Joint-sealant application, joint location, and designation.
 2. Joint-sealant manufacturer and product name.
 3. Joint-sealant formulation.
 4. Joint-sealant color.
- E. Shop Drawings: Prepared by or under the supervision of a qualified professional, detailing fabrication and assembly.
1. Submit shop drawings within a reasonable time so as not to delay the start of material fabrication and installation.
 2. Submit shop drawings per above allowing a minimum review time of 10 business days for review and response. Per above, also allow enough time for revisions and resubmittal where reasonably predictable.
 3. Shop drawings shall show the proposed layout identifying all components and details based on field verified conditions and measurements.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and Manufacturer.
- B. Material Certificates: For each of the following, signed by manufacturers:
1. For all materials.
- C. Material Test Reports: For the following, from a qualified testing agency:
1. For all materials.
- D. Preconstruction test reports.
- E. Source quality-control test reports.
- A. Field quality-control and special inspection reports.
- B. Minutes of pre-installation conference.

- C. Maintenance Instructions.
- D. Warranty: Written manufacturer's warranty.

1.8 CLOSEOUT SUBMITTALS

- A. Maintenance Data.

1.9 CLOSEOUT SUBMITTALS

- A. Maintenance Data: From Installer including a recommended maintenance plan with procedures for inspection and care during a calendar year. Submit before start of required warranty and maintenance periods

1.10 MAINTENANCE MATERIAL SUBMITTALS

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

1.11 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Authorities Having Jurisdiction for all work included in this section.
 - 1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.
- B. Codes and Standards: Conform work to all applicable codes and standards.
- C. Manufacturer Qualifications: Provide manufacturer qualifications as follows:
 - 1. Submit a list of ten completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.
 - 2. Submit qualifications of manufacturer.
 - 3. Submit manufacturer's quality control program.
 - 4. Submit example of Material Warranty and any other applicable warranties.
- D. Installer Qualifications: Provide installer qualifications as follows:
 - 1. Submit a list of ten completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.
 - 2. Submit resumes and/or qualifications of installation manager(s).
 - 3. Submit fabrication quality control program.
 - 4. Submit installation quality control program.

5. Submit example of Material Warranty and any other applicable warranties.

E. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified for testing indicated. Provide testing agency qualification as follows:

1. Submit a list of ten completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.
2. Submit resumes and/or qualifications of testing manager(s).
3. Submit testing quality control program.
4. Submit example of Material Warranty and any other applicable warranties.

1.12 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform all required preconstruction testing.

1.13 DELIVERY, STORAGE AND HANDLING

A. Deliver packaged products in an undamaged condition in original containers, displaying manufacturer's labels, along with instructions for handling, storing, unpacking, protecting, and installing.

B. Deliver and store materials in manufacturer's original containers, with seals unbroken and identification labels intact until time of use.

C. Deliver products to achieve the shortest duration of storage time as practicable.

D. Deliver all chemical products in original, unopened containers with original labels intact and legible, which state the guaranteed chemical analysis. Store all chemicals in weather protected enclosure.

E. Comply with manufacturer's written instructions for delivery, storage, and handling, and as required to prevent damage to products and work during construction.

F. Store products and materials in a neat and orderly manner. Maintain clear aisles and access to work areas. Protect stored products from theft and damage. Store products above ground in weathertight, ventilated packaging or enclosures.

G. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

H. Store liquids in tightly closed containers protected from freezing.

I. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.

J. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

1.14 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of all site elements and other construction contiguous with the work of this section prior to fabrication and/or installation.
- B. The work shall not occur in the presence of standing water, mud, snow, or frozen subgrade conditions. Work shall not occur while precipitation is occurring or during excessive winds, or when temperatures are outside the limits specified in this specification. Work completed during these conditions will be rejected.
- C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
- D. Hot-Weather Requirements: Comply with hot-weather construction requirements.
- E. Do not proceed with installation of joint sealants under the following conditions:
 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
 2. When joint substrates are wet.
 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.15 EXCAVATING AND GRADING AROUND UTILITIES

- A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.
- B. Determine location of underground utilities and perform work in a manner that will avoid damage. Hand excavate as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.
- C. Notification of the utility locate services is required for all Excavation and grading deeper than 12 inches: The Contractor is responsible for knowing the location and avoiding utilities that are not covered by the local utility locator service.

1.16 OBSERVATION OF THE WORK

- A. The Landscape Architect may observe the work at any time. They may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting specifications shall be paid by the Contractor.
- B. The Landscape Architect shall be informed of the progress of the work so the work may be observed during key times in the construction process. The Landscape Architect shall be afforded sufficient time to schedule visits to the site. Failure of the Landscape Architect to make field observations shall not relieve the Contractor from meeting all the requirements of this specification.

1.17 FIRST WORK IN PLACE

- A. The Landscape Architect shall be informed once the first work in place has been completed for all individual elements included in this section for review to ensure the work is proceeding in accordance with the approved samples and mockups and per the Contract Documents. The Landscape Architect shall be afforded sufficient time to schedule visits to the site for review. In the event that sufficient time cannot be provided the Contractor shall provide images from multiple angles and perspectives of the work for Landscape Architect review.

1.18 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering and wear.
 - b. Separation or delamination of materials and components.
 - 2. Warranty Period: One year from date of Substantial Completion.

1.19 MAINTENANCE SERVICE

- A. Contractor to provide standard industry maintenance on all scope items herein until Final Acceptance.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and

application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.2 COLD-APPLIED JOINT SEALANTS

- A. Single-Component, Self-Leveling, Silicone Joint Sealant: ASTM D 5893/D 5893M, Type SL.

2.3 JOINT-SEALANT BACKER MATERIALS

- A. Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.
- B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
- C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

2.4 PRIMERS

- A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Prior to installation examine site to confirm that existing conditions are satisfactory for the work of this section to proceed.
- B. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope toward the under drain lines as shown on the drawings.
- C. Confirm that no adverse drainage conditions are present.
- D. Confirm that no conditions are present which are detrimental to plant growth.
- E. Confirm that utility work has been completed per the drawings.
- F. If unsatisfactory conditions are encountered, notify the Landscape Architect immediately to determine corrective action prior to proceeding.

3.2 EXAMINATION

- A. Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

- A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.4 COORDINATION WITH PROJECT WORK

- A. The Contractor is responsible for investigating, and being aware of, the work requirements of their sub-contractors and other contractors. The Contractor shall coordinate with all other work that may impact the completion of the work herein.
- B. Prior to the start of work, prepare a detailed schedule of the work for coordination with other trades.

3.5 INSTALLATION OF JOINT SEALANTS

- A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.
- B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions.
- C. Install joint-sealant backings to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of joint-sealant backings.
 - 2. Do not stretch, twist, puncture, or tear joint-sealant backings.

3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install joint sealants immediately following backing installation, using proven techniques that comply with the following:
 1. Place joint sealants so they fully contact joint substrates.
 2. Completely fill recesses in each joint configuration.
 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:
 1. Remove excess joint sealant from surfaces adjacent to joints.
 2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.6 GRADE, ELEVATION AND ALIGNMENT CONTROL

- A. Provide grade and elevation control during installation of the work of this section. Utilize grade stakes, string lines, surveying equipment, and other means and methods to assure that grades and contours conform to the grades indicated on the plans.
- B. Provide alignment control during installation of the work of this section. Utilize stakes, pins, marking techniques, string lines, surveying equipment, and other means and methods to assure that alignments conform to the alignments on the plans.

3.7 REPAIR AND REPLACEMENT

- A. General: Repair or replace that is damaged by construction operations, in a manner approved by Landscape Architect.

3.8 WASTE HANDLING

- A. General: Handle waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

3.9 CLEANING

- A. The contractor should clean the job site and remove any excess materials. Coordinate with Owner for storage locations for any Attic Stock materials where applicable.

- B. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.

3.10 PROTECTION

- A. Contractor shall furnish and install construction fence around new installations to prevent access. Fencing shall be maintained in place for a minimum of 48 hours after completion of installation, or as directed by the Landscape Architect. Drying period may take longer due to weather conditions.
- B. Contractor shall notify Landscape Architect that landscape irrigation shall be restricted near installations until applicable drying period is complete. Standing water on installations shall be restricted at all times.
- C. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.11 MAINTENANCE SERVICE

- A. Maintenance Service: Provide maintenance by skilled employees of Installer or approved Subcontractor. Maintain as required in "Maintenance" Article. Begin maintenance immediately after scope is installed and continue until final acceptance.

3.12 DEMONSTRATION AND TRAINING

- A. Engage a manufacturer-authorized service representative and/or other authorized professional to train Owner's maintenance personnel to adjust and operate all components herein.
- B. Train Owner's maintenance personnel in proper maintenance procedures for all components herein.

END OF SECTION - 32 13 73

SECTION 32 14 00 – UNIT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Pre-cast concrete pavers.

- B. Related Requirements:

- 1. Section 32 13 13 "Concrete Paving" for concrete base under unit pavers and for cast-in-place concrete curbs and gutters serving as edge restraints for unit pavers.

1.3 PERMITS AND FEES

- A. Permits: The Contractor shall secure and pay for all permits, inspections, and certificates of inspection of any governmental and inspection body having jurisdiction over all or any part of the work included under this section and/or such inspections etc., required by these specifications.
- B. Fees: The Contractor shall secure and pay for all fees and assessments in connection with the work under this contract and shall include this cost in its bid and contract price.

1.4 PRE-INSTALLATION MEETINGS

- A. Pre-installation Meeting: Conduct meeting at Project Site, Manufacturer's Facility of Fabricator's Shop. Confirm with Owner and Landscape Architect 14 days prior to conference.
 - 1. Before submitting submittals, review submittals, mockup and other requirements of this section and examine procedures for ensuring quality of the scope herein. Require representatives of each entity directly concerned with the scope herein, including but not limited to, the following:
 - a. Contractor's superintendent.
 - b. Subcontractor.
 - c. Special Subcontractor.
 - d. Independent testing agency responsible for testing.
 - e. Product manufacturer and/or local representative.

- f. Authority Having Jurisdiction.
 - g. Landscape Architect.
2. Review methods and procedures related to the work of this section, including but not limited to, the following:
- a. Responsibilities of each party.
 - b. Coordination of Landscape Architect's review of the work, including but not limited to:
 - 1) Site or Shop Visits to Review Samples and Mockups
 - 2) Site Visits to Observe General Construction Progress
 - 3) Site or Shop Visits to Review Fabrication Progress
 - 4) Site Visits to Review First Work In Place
 - 5) Site Visits for Punch List Review
 - 6) Site Visits for Punch List Completion Review
 - 7) Site Visit for Warranty Review
 - c. Lines of authority and communication for the project. Procedures for resolution of any project document ambiguity.
 - d. Methods for documenting, reporting, and distributing documents and reports.
 - e. Proposed sources of materials.
 - f. Procedures for packaging and storing archive samples.
 - g. Review of the time schedule for all installation and testing. Schedule of workdays and/or starting times if third party testing verification is required.
 - h. Quality control.
 - i. Temperature and weather limitations. Installation procedures for adverse weather conditions. Defining acceptable subgrade or ambient moisture and temperature conditions for working during installation.
 - j. Subgrade conditions, dewatering responsibilities, and subgrade maintenance plan.
 - k. Deployment techniques including allowable subgrade conditions.
 - l. Construction, material placement, and backfilling.
 - m. Requirements for protecting work, including restriction of traffic and adjacent work impacting during installation period and for remainder of construction period.
 - n. Measurement and payment schedules.
 - o. Health and safety.
 - p. Procedures and responsibilities for preparation and submission of as-built drawings.

1.5 COORDINATION

- A. Refer to Division 1 Requirements.

1.6 ACTION SUBMITTALS

- A. Product Data: For materials other than water and aggregates.
- B. Product Data: For the following:
 - 1. Manufacturer's Product Literature and Specification Data.

2. Manufacturer's written instructions for recommended maintenance practices.
 3. Color and finish samples for verification and selection.
 4. Written manufacturer's warranty.
 5. Product liability insurance certificate with project owner as certificate holder.
 6. MSDS for items in Part 2 "Products."
 7. Pavers.
 8. Bituminous setting materials.
 9. Mortar and grout materials.
 10. Edge restraints.
 11. Precast concrete curbs.
 12. Granite curbs.
- C. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C 136.
- D. Samples for Initial Selection: For each type of unit paver indicated and the following:
1. Joint materials involving color selection.
 2. Exposed edge restraints involving color selection.
- E. Samples for Verification: For full-size units of each type of unit paver indicated. Assemble no fewer than five Samples of each type of unit on suitable backing and grout joints. Include Samples of the following:
1. Joint materials.
 2. Exposed edge restraints.
 3. Precast concrete curbs.
 4. Granite curbs.
- F. Shop Drawings: Prepared by or under the supervision of a qualified professional, detailing fabrication and assembly.
1. Submit shop drawings within a reasonable time so as not to delay the start of material fabrication and installation.
 2. Submit shop drawings per above allowing a minimum review time of 10 business days for review and response. Per above, also allow enough time for revisions and resubmittal where reasonably predictable.
 3. Shop drawings shall show the proposed layout identifying all components and details based on field verified conditions and measurements.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, Fabricator, Manufacturer and Testing agency.
- B. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.
- C. Material Test Reports: For the following, from a qualified testing agency:

1. For all materials.
 - D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for unit pavers, indicating compliance with requirements.
 1. For solid interlocking paving units, include test data for freezing and thawing according to ASTM C 67.
 - E. Adhesion and Compatibility Test Reports: From latex-additive manufacturer for mortar and grout containing latex additives.
 - F. Preconstruction test reports.
 - G. Source quality-control test reports.
 - A. Field quality-control and special inspection reports.
 - B. Minutes of pre-installation conference.
 - C. Maintenance Instructions.
 - D. Warranty: Written manufacturer's warranty.
- 1.8 CLOSEOUT SUBMITTALS
- A. Maintenance Data: From Installer including a recommended maintenance plan with procedures for inspection and care during a calendar year. Submit before start of required warranty and maintenance periods
- 1.9 MAINTENANCE MATERIAL SUBMITTALS
- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents
- 1.10 QUALITY ASSURANCE
- A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Authorities Having Jurisdiction for all work included in this section.
 - B. Codes and Standards: Conform work to all applicable codes and standards.
 - C. Manufacturer Qualifications: Provide manufacturer qualifications as follows:
 1. Submit a list of ten completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.
 2. Submit qualifications of manufacturer.

3. Submit manufacturer's quality control program.
4. Submit example of Material Warranty and any other applicable warranties.

D. Installer Qualifications: Provide installer qualifications as follows:

1. Submit a list of ten completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.
2. Submit resumes and/or qualifications of installation manager(s).
3. Submit fabrication quality control program.
4. Submit installation quality control program.
5. Submit example of Material Warranty and any other applicable warranties.

E. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified for testing indicated. Provide testing agency qualification as follows:

1. Submit a list of ten completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.
2. Submit resumes and/or qualifications of testing manager(s).
3. Submit testing quality control program.
4. Submit example of Material Warranty and any other applicable warranties.

F. Mockups: Provide mockup for each type of component per the Drawings and/or shop drawing.

1. Build mockups of full-profile sections to demonstrate including but not limited to overall material quality, typical joints; typical transitions, surface finish, surface texture, color; and standard of workmanship.
2. Build mockups in the location and of the size indicated. Build mockups where directed by Landscape Architect.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Landscape Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may not become part of the completed work.
5. Mockups to be retained on site or at approved location by Owner and Landscape Architect until all related work scope is deemed Substantially Complete.
6. Contractor to rework mockups as necessary until mockups are accepted.

1.11 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Submit to latex-additive manufacturer, for testing as indicated below, Samples of flooring materials that will contact or affect mortar and grout that contain latex additives.

1. Use manufacturer's standard test methods to determine whether mortar and grout materials will obtain optimal adhesion with, and will be nonstaining to, installed brick and other materials constituting brick flooring installation.

1.12 DELIVERY, STORAGE, AND HANDLING

- A. Deliver packaged products in an undamaged condition in original containers, displaying manufacturer's labels, along with instructions for handling, storing, unpacking, protecting, and installing.
- B. Deliver and store materials in manufacturer's original containers, with seals unbroken and identification labels intact until time of use.
- C. Deliver products to achieve the shortest duration of storage time as practicable.
- D. Deliver all chemical products in original, unopened containers with original labels intact and legible, which state the guaranteed chemical analysis. Store all chemicals in weather protected enclosure.
- E. Comply with manufacturer's written instructions for delivery, storage, and handling, and as required to prevent damage to products and work during construction.
- F. Store products and materials in a neat and orderly manner. Maintain clear aisles and access to work areas. Protect stored products from theft and damage. Store products above ground in weathertight, ventilated packaging or enclosures.
- G. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.
- H. Store liquids in tightly closed containers protected from freezing.
- I. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- J. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk materials with appropriate certificates.
- K. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
- L. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- M. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

- N. Store liquids in tightly closed containers protected from freezing.
- O. Store asphalt cement and other bituminous materials in tightly closed containers.

1.13 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of all site elements and other construction contiguous with the work of this section prior to fabrication and/or installation.
- B. The work shall not occur in the presence of standing water, mud, snow, or frozen subgrade conditions. Work shall not occur while precipitation is occurring or during excessive winds, or when temperatures are outside the limits specified in this specification. Work completed during these conditions will be rejected.
- C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
- D. Hot-Weather Requirements: Comply with hot-weather construction requirements.
- E. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
- F. Weather Limitations for Bituminous Setting Bed:
 - 1. Install bituminous setting bed only when ambient temperature is above 40 deg F (4 deg C) and when base is dry.
 - 2. Apply asphalt adhesive only when ambient temperature is above 50 deg F (10 deg C) and when temperature has not been below 35 deg F (2 deg C) for 12 hours immediately before application. Do not apply when setting bed is wet or contains excess moisture.
- G. Weather Limitations for Mortar and Grout:
 - 1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
 - 2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F (38 deg C) and higher.
 - a. When ambient temperature exceeds 100 deg F (38 deg C), or when wind velocity exceeds 8 mph (13 km/h) and ambient temperature exceeds 90 deg F (32 deg C), set pavers within 1 minute of spreading setting-bed mortar.

1.14 PERMEABLE CONCRETE PAVER OVERAGE AND ATTIC STOCK

- A. Provide a minimum of 5% additional material for overage to be used during construction.

- B. Furnish 100 square feet of each product and size used to owner for maintenance and repair. Furnish Permeable Concrete Pavers from the same production run as installed materials.
- C. Manufacture to supply maintenance and reinstatement manuals for Permeable Concrete Paver units.

1.15 EXCAVATING AND GRADING AROUND UTILITIES

- A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.
- B. Determine location of underground utilities and perform work in a manner that will avoid damage. Hand excavate as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.
- C. Notification of the utility locate services is required for all Excavation and grading deeper than 12 inches: The Contractor is responsible for knowing the location and avoiding utilities that are not covered by the local utility locator service.

1.16 OBSERVATION OF THE WORK

- A. The Landscape Architect may observe the work at any time. They may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting specifications shall be paid by the Contractor.
- B. The Landscape Architect shall be informed of the progress of the work so the work may be observed during key times in the construction process. The Landscape Architect shall be afforded sufficient time to schedule visits to the site. Failure of the Landscape Architect to make field observations shall not relieve the Contractor from meeting all the requirements of this specification.

1.17 FIRST WORK IN PLACE

- A. The Landscape Architect shall be informed once the first work in place has been completed for all individual elements included in this section for review to ensure the work is proceeding in accordance with the approved samples and mockups and per the Contract Documents. The Landscape Architect shall be afforded sufficient time to schedule visits to the site for review. In the event that sufficient time cannot be provided the Contractor shall provide images from multiple angles and perspectives of the work for Landscape Architect review.

1.18 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering and wear.
 - b. Separation or delamination of materials and components.
 2. Warranty Period: One year from date of Substantial Completion.
- B. Unit Paver Material Warranty: Manufacturer to Provide a (2) year limited warranty on the structural integrity of the unit paver material installed for the above referenced project.
1. Provide replacement product for properly installed material per industry standard installation guidelines that prove defective at no charge. (Reference the Interlocking Concrete Pavement Institute Standards for applicable Concrete Pavers). A copy of the final construction documents and base specifications shall be made available to manufacturer upon request. Damage from base or sub-base failure is not covered under this warranty. Color matching cannot be guaranteed and replacement labor is not included. Other exclusions include:
 - a. Paver breakage due to handling and drops.
 - b. Heavy equipment or construction damage.
 - c. Neglect, negligence, vandalism or acts of God.
 2. This limited warranty covers the product only. This includes any product defects causing cracking, breakage or deterioration of the units. Manufacturer no responsible for warranty from normal wearing such as chipping or scraping.

1.19 MAINTENANCE SERVICE

- A. Contractor to provide standard industry maintenance on all scope items herein until Final Acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 CONCRETE PAVERS

- A. Concrete Pavers (At-Grade): Solid interlocking paving units complying with ASTM C 936/C 936M and resistant to freezing and thawing when tested according to ASTM C 67, made from normal-weight aggregates.

1. PP-01:

- a. Manufacturer: See hardscape schedule.
- b. Product: See hardscape schedule.
- c. Color: See hardscape schedule.

2.3 AGGREGATE SETTING-BED MATERIALS

- A. Graded Aggregate for Subbase: Sound, crushed stone or gravel complying with [**ASTM D 448 for Size No. 57**] [**ASTM D 2940/D 2940M, subbase material**] [**requirements in Section 312000 "Earth Moving" for subbase material**].
- B. Graded Aggregate for Base: Sound, crushed stone or gravel complying with [**ASTM D 448 for Size No. 8**] [**ASTM D 2940/D 2940M, base material**] [**requirements in Section 312000 "Earth Moving" for base course**].
- C. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33/C 33M for fine aggregate.
- D. Stone Screenings for Leveling Course: Sound stone screenings complying with ASTM D 448 for Size No. 10.
- E. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 (1.18-mm) sieve and no more than 10 percent passing No. 200 (0.075-mm) sieve.
 1. Provide sand of color needed to produce required joint color.
- F. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications; made from polyolefins or polyesters, with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
 1. Survivability: Class 2, AASHTO M 288.
 2. Apparent Opening Size: No. 60 (0.250-mm) sieve, maximum; ASTM D 4751.
 3. Permittivity: 0.02 per second, minimum; ASTM D 4491.
 4. UV Stability: 50 percent after 500 hours' exposure, ASTM D 4355.
- G. Drainage Geotextile: Nonwoven needle-punched geotextile fabric, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
 1. Survivability: Class 2, AASHTO M 288.
 2. Apparent Opening Size: No. 40 (0.425-mm) sieve, maximum; ASTM D 4751.
 3. Permittivity: 0.5 per second, minimum; ASTM D 4491.
 4. UV Stability: 50 percent after 500 hours' exposure, ASTM D 4355.
- H. Herbicide: Commercial chemical for weed control, registered with the EPA. Provide in granular, liquid, or wettable powder form.

2.4 BITUMINOUS SETTING-BED MATERIALS

- A. Primer for Base: ASTM D 2028/D 2028M, cutback asphalt, grade as recommended by unit paver manufacturer.
- B. Fine Aggregate for Setting Bed: ASTM D 1073, No. 2 or No. 3.
- C. Asphalt Cement: ASTM D 3381/D 3381M, Viscosity Grade AC-10 or Grade AC-20.
- D. Neoprene-Modified Asphalt Adhesive: Paving manufacturer's standard adhesive consisting of oxidized asphalt combined with 2 percent neoprene and 10 percent long-fibered mineral fibers containing no asbestos.
- E. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 (1.18-mm) sieve and no more than 10 percent passing No. 200 (0.075-mm) sieve.
 - 1. Provide sand of color needed to produce required joint color.

2.5 BITUMINOUS SETTING-BED MIX

- A. Mix bituminous setting-bed materials at an asphalt plant in approximate proportion, by weight, of 7 percent asphalt cement to 93 percent fine aggregate unless otherwise indicated. Heat mixture to 300 deg F (149 deg C).

2.6 GEOTEXTILE

- A. Provide Geotextile material conforming to the following performance characteristics, measured per the test methods referenced:
 - 1. 4 oz., nonwoven needle punched geotextile composed of 100% polypropylene staple fibers that are inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids.
 - 2. Grab Tensile Strength: ASTM D 4632: 115 lbs.
 - 3. Grab Tensile Elongation: ASTM D 4632: 50%
 - 4. Trapezoidal Tear: ASTM D4533: 50 lbs.
 - 5. Puncture: ASTM D4833: 65 lbs.
 - 6. Apparent Opening Size: ASTM D 4751: 0.212 mm, 70 U.S. Sieve
 - 7. Permittivity: ASTM D 4491: 2.0 sec -1
 - 8. Flow Rate: ASTM D 4491: 140 gal/min/s.f.
- B. As supplied by Unilock
 - 1. Carthage Mills – FX-40HS
 - 2. U.S. Fabrics – US 115NW
 - 3. Mirafi – 140N

2.7 ACCESSORIES

- A. Cork Joint Filler: Preformed strips complying with ASTM D 1752, Type II.
- B. Compressible Foam Filler: Preformed strips complying with ASTM D 1056, Grade 2A1.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Prior to installation examine site to confirm that existing conditions are satisfactory for the work of this section to proceed.
- B. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope toward the under drain lines as shown on the drawings.
- C. Confirm that no adverse drainage conditions are present.
- D. Confirm that no conditions are present which are detrimental to plant growth.
- E. Confirm that utility work has been completed per the drawings.
- F. If unsatisfactory conditions are encountered, notify the Landscape Architect immediately to determine corrective action prior to proceeding.

3.2 EXAMINATION

- A. Examine surfaces indicated to receive unit paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Where unit paving is to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations, including areas where waterproofing system is turned up or flashed against vertical surfaces.
- C. Proceed with installation only after unsatisfactory conditions have been corrected and waterproofing protection is in place.

3.3 PREPARATION

- A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.
- B. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.

3.4 COORDINATION WITH PROJECT WORK

- A. The Contractor is responsible for investigating, and being aware of, the work requirements of their sub-contractors and other contractors. The Contractor shall coordinate with all other work that may impact the completion of the work herein.
- B. Prior to the start of work, prepare a detailed schedule of the work for coordination with other trades.

3.5 INSTALLATION, GENERAL

- A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.
- B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
- C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
 - 1. For concrete pavers, a block splitter may be used.
- D. Handle protective-coated brick pavers to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.
- E. Joint Pattern: As indicated.
- F. Pavers over Waterproofing: Exercise care in placing pavers and setting materials over waterproofing so protection materials are not displaced and waterproofing is not punctured or otherwise damaged. Carefully replace protection materials that become displaced and arrange for repair of damaged waterproofing before covering with paving.
 - 1. Provide joint filler at waterproofing that is turned up on vertical surfaces unless otherwise indicated; where unfilled joints are indicated, provide temporary filler or protection until paver installation is complete.
- G. Tolerances: Do not exceed 1/32-inch (0.8-mm) unit-to-unit offset from flush (lippage) or 1/8 inch in 10 feet (3 mm in 3 m) from level, or indicated slope, for finished surface of paving.
- H. Tolerances: Do not exceed 1/16-inch (1.6-mm) unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches (3 mm in 600 mm) and 1/4 inch in 10 feet (6 mm in 3 m) from level, or indicated slope, for finished surface of paving.
- I. Expansion and Control Joints: Provide for sealant-filled joints at locations and of widths indicated. Provide compressible foam filler as backing for sealant-filled joints unless otherwise indicated; where unfilled joints are indicated, provide temporary filler until paver installation is

complete. Install joint filler before setting pavers. Sealant materials and installation are specified in Section 07 92 00 "Joint Sealants."

- J. Expansion and Control Joints: Provide cork joint filler at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers.
- K. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
 - 1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.
 - 2. For metal edge restraints with top edge exposed, drive stakes at least 1 inch (25 mm) below top edge.
 - 3. Install job-built concrete edge restraints to comply with requirements in Section 03 30 00 "Cast-in-Place Concrete."
 - 4. Where pavers set in mortar bed are indicated as edge restraints for pavers set in aggregate setting bed, install pavers set in mortar and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.
 - 5. Where pavers embedded in concrete are indicated as edge restraints for pavers set in aggregate setting bed, install pavers embedded in concrete and allow concrete to cure before placing aggregate setting bed and remainder of pavers. Hold top of concrete below aggregate setting bed.
- L. Provide steps made of pavers as indicated. Install paver steps before installing adjacent pavers.
 - 1. Where pavers set in mortar bed are indicated for steps constructed adjacent to pavers set in aggregate setting bed, install steps and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.

3.6 INSTALLATION (PERMEABLE PAVERS)

A. GEOTEXTILES

- 1. Provide separation geotextile on bottom and sides of prepared soil subgrade. Secure in place to prevent wrinkling or folding from equipment tires and tracks.
- 2. Overlap ends and edges a minimum of 18 in. (450 mm) in the direction of drainage.

3.7 BITUMINOUS SETTING-BED APPLICATIONS

- A. Apply primer to concrete slab or binder course immediately before placing setting bed.
- B. Prepare for setting-bed placement by locating 3/4-inch- (19-mm-) deep control bars approximately 11 feet (3.3 m) apart and parallel to one another, to serve as guides for striking board. Adjust bars to subgrades required for accurate setting of paving units to finished grades indicated.

- C. Place bituminous setting bed where indicated, in panels, by spreading bituminous material between control bars. Spread mix at a minimum temperature of 250 deg F (121 deg C). Strike setting bed smooth, firm, even, and not less than 3/4 inch (19 mm) thick. Add fresh bituminous material to low, porous spots after each pass of striking board. After each panel is completed, advance first control bar to next position in readiness for striking adjacent panels. Carefully fill depressions that remain after removing depth-control bars.
 - 1. Roll setting bed with power roller to a nominal depth of 3/4 inch (19 mm). Adjust thickness as necessary to allow accurate setting of unit pavers to finished grades indicated. Complete rolling before mix temperature cools to 185 deg F (85 deg C).
- D. Apply neoprene-modified asphalt adhesive to cold setting bed by squeegeeing or troweling to a uniform thickness of 1/16 inch (1.6 mm). Proceed with setting of paving units only after adhesive is tacky and surface is dry to touch.
- E. Place pavers carefully by hand in straight courses, maintaining accurate alignment and uniform top surface. Protect newly laid pavers with plywood panels on which workers can stand. Advance protective panels as work progresses, but maintain protection in areas subject to continued movement of materials and equipment to avoid creating depressions or disrupting alignment of pavers. If additional leveling of paving is required, and before treating joints, roll paving with power roller after sufficient heat has built up in the surface from several days of hot weather.
- F. Joint Treatment: Place unit pavers with hand-tight joints. Fill joints by sweeping sand over paved surface until joints are filled. Remove excess sand after joints are filled.

3.8 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.
- B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.
- C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.
 - 1. Remove temporary protective coating as recommended by coating manufacturer and as acceptable to paver and grout manufacturers.
 - 2. Do not allow protective coating to enter floor drains. Trap, collect, and remove coating material.

3.9 GRADE, ELEVATION AND ALIGNMENT CONTROL

- A. Provide grade and elevation control during installation of the work of this section. Utilize grade stakes, string lines, surveying equipment, and other means and methods to assure that grades and contours conform to the grades indicated on the plans.

- B. Provide alignment control during installation of the work of this section. Utilize stakes, pins, marking techniques, string lines, surveying equipment, and other means and methods to assure that alignments conform to the alignments on the plans.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

3.11 REPAIR AND REPLACEMENT

- A. General: Repair or replace that is damaged by construction operations, in a manner approved by Landscape Architect.

3.12 WASTE HANDLING

- A. General: Handle waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

3.13 CLEANING

- A. The contractor should clean the job site and remove any excess materials. Coordinate with Owner for storage locations for any Attic Stock materials where applicable.

3.14 PROTECTION

- A. Contractor shall furnish and install construction fence around new installations to prevent access. Fencing shall be maintained in place for a minimum of 48 hours after completion of installation, or as directed by the Landscape Architect. Drying period may take longer due to weather conditions.
- B. Contractor shall notify Landscape Architect that landscape irrigation shall be restricted near installations until applicable drying period is complete. Standing water on installations shall be restricted at all times.

3.15 MAINTENANCE SERVICE

- A. Maintenance Service: Provide maintenance by skilled employees of Installer or approved Subcontractor. Maintain as required in "Maintenance" Article. Begin maintenance immediately after scope is installed and continue until final acceptance.

3.16 DEMONSTRATION AND TRAINING

- A. Engage a manufacturer-authorized service representative and/or other authorized professional to train Owner's maintenance personnel to adjust and operate all components herein.

- B. Train Owner's maintenance personnel in proper maintenance procedures for all components herein.

END OF SECTION – 32 14 00

SECTION 32 15 43 – STABILIZED AGGREGATE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes material and labor requirements for construction with decomposed granite or crushed 3/8" or 1/4" minus aggregate pathway with Stabilizer® binder additive for the following items:
 - 1. Stabilized Aggregate, SEE SCHEDULE.
- B. Related Sections:
 - 1. Section 32 15 50 "Metal Edging."

1.3 PRE-INSTALLATION MEETINGS

- A. Pre-installation Meeting: Conduct meeting at Project Site, Manufacturer's Facility of Fabricator's Shop. Confirm with Owner and Landscape Architect 14 days prior to conference.
 - 1. Before submitting submittals, review submittals, mockup and other requirements of this section and examine procedures for ensuring quality of the scope herein. Require representatives of each entity directly concerned with the scope herein, including but not limited to, the following:
 - a. Contractor's superintendent.
 - b. Subcontractor.
 - c. Special Subcontractor.
 - d. Product manufacturer and/or local representative.
 - e. Landscape Architect.
 - 2. Review methods and procedures related to the work of this section, including but not limited to, the following:
 - a. Responsibilities of each party.
 - b. Coordination of Landscape Architect's review of the work, including but not limited to:
 - 1) Site or Shop Visits to Review Samples and Mockups
 - 2) Site Visits to Observe General Construction Progress
 - 3) Site or Shop Visits to Review Fabrication Progress
 - 4) Site Visits to Review First Work In Place

- 5) Site Visits for Punch List Review
- 6) Site Visits for Punch List Completion Review
- 7) Site Visit for Warranty Review
- c. Lines of authority and communication for the project. Procedures for resolution of any project document ambiguity.
- d. Methods for documenting, reporting, and distributing documents and reports.
- e. Proposed sources of materials.
- f. Procedures for packaging and storing archive samples.
- g. Review of the time schedule for all installation and testing. Schedule of workdays and/or starting times if third party testing verification is required.
- h. Quality control.
- i. Temperature and weather limitations. Installation procedures for adverse weather conditions. Defining acceptable subgrade or ambient moisture and temperature conditions for working during installation.
- j. Subgrade conditions, dewatering responsibilities, and subgrade maintenance plan.
- k. Deployment techniques including allowable subgrade conditions.
- l. Construction, material placement, and backfilling.
- m. Requirements for protecting work, including restriction of traffic and adjacent work impacting during installation period and for remainder of construction period.
- n. Measurement and payment schedules.
- o. Health and safety.
- p. Procedures and responsibilities for preparation and submission of as-built drawings.

1.4 COORDINATION

- A. Refer to Division 1 Requirements.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Manufacturer's Product Literature and Specification Data.
 2. Manufacturer's written instructions for recommended maintenance practices.
 3. Color and finish samples for verification and selection.
 4. Written manufacturer's warranty.
 5. Product liability insurance certificate with project owner as certificate holder.
 6. MSDS for items in Part 2 "Products."
 7. Include technical data and tested physical and performance properties.
 8. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
 9. Job-Mix Designs: For each job mix proposed for the Work.
- B. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.

- C. Samples for Verification: For the following product, in manufacturer's standard sizes unless otherwise indicated:
 - 1. Aggregate: Provide samples of each aggregate type and color (3) different sources for client and landscape Landscape Architect approval for each aggregate type. Submit minimum of 1-lb of aggregate in a clear heavy-duty zip-seal bag. Rework mix as required at the direction of the Landscape Landscape Architect to achieve an acceptable texture, color and finish. Samples shall be reworked and reconstructed as necessary until the required standard of work has been achieved at no cost to the Owner.
- D. Shop Drawings: Prepared by or under the supervision of a qualified professional, detailing fabrication and assembly.
 - 1. Submit shop drawings within a reasonable time so as not to delay the start of material fabrication and installation.
 - 2. Submit shop drawings per above allowing a minimum review time of 10 business days for review and response. Per above, also allow enough time for revisions and resubmittal where reasonably predictable.
 - 3. Shop drawings shall show the proposed layout identifying all components and details based on field verified conditions and measurements.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, manufacturer and testing agency.
- B. Material Certificates: For each paving material. Include statement that mixes containing recycled materials will perform equal to mixes produced from all new materials.
- C. Material Test Reports: For each paving material, by a qualified testing agency.
- D. Preconstruction test reports.
- E. Source quality-control test reports.
- A. Field quality-control and special inspection reports.
- B. Minutes of pre-installation conference.
- C. Maintenance Instructions.
- D. Warranty: Written manufacturer's warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Installer to provide evidence to indicate successful experience in providing Stabilized Aggregate surface or ability to follow installation instructions.
- B. Mock-ups: Install 4 ft. wide x 10 ft. long mock-up of decomposed granite or 3/8" or 1/4" minus crushed aggregate surfacing with Stabilizer® additive at location specified by owner's representative.
- C. Compaction testing to be provided by contractor, one test per 2,000 square feet of base course.
- D. Manufacturer's technical representative shall visit the site at the start of an installation to ensure the installer understands the correct installation methods to use.
- E. Illinois Accessibility Code: Do not exceed longitudinal slope of 1:20 (5%) or cross-slope of 1:50 (2%) for new walkways. New walkways shall be sloped to meet existing walkway.
- F. Americans with Disabilities Act: Comply with all current rules and regulations as set forth in the Americans with Disabilities Act.
- G. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located.
- H. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.
- I. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of authority having jurisdiction for aggregate paving work.
- J. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockups of full-thickness sections of aggregate paving to demonstrate typical surface finish, texture, and color; and standard of workmanship.
 - 2. Build mockups of aggregate paving in the location and of the size indicated or, if not indicated, build mockups where directed by the Landscape Architect and not less than 120 inches (3048 mm) by 120 inches (3048 mm) Include examples of all surface and edge conditions.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Landscape Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
 - 5. Mockups to be retained on site or at approved location by Owner and Landscape Architect until all related work scope is deemed Substantially Complete.
 - 6. Contractor to rework mockups as necessary until mockups are accepted.

1.9 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on aggregate paving mixtures.

1.10 DELIVERY STORAGE AND HANDLING

- A. Deliver packaged products in an undamaged condition in original containers, displaying manufacturer's labels, along with instructions for handling, storing, unpacking, protecting, and installing.
- B. Deliver and store materials in manufacturer's original containers, with seals unbroken and identification labels intact until time of use.
- C. Deliver products to achieve the shortest duration of storage time as practicable.
- D. Deliver all chemical products in original, unopened containers with original labels intact and legible, which state the guaranteed chemical analysis. Store all chemicals in weather protected enclosure.
- E. Comply with manufacturer's written instructions for delivery, storage, and handling, and as required to prevent damage to products and work during construction.
- F. Store products and materials in a neat and orderly manner. Maintain clear aisles and access to work areas. Protect stored products from theft and damage. Store products above ground in weathertight, ventilated packaging or enclosures.
- G. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.
- H. Store liquids in tightly closed containers protected from freezing.
- I. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- J. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk materials with appropriate certificates.

1.11 FIELD CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Cold-Weather Placement: Protect work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
 - 1. Do not use frozen materials or materials containing ice or snow.
 - 2. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved.
- C. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and as follows when hot-weather conditions exist:
- D. Field Measurements: Each bidder is required 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. Where surfacing is indicated to fit with other construction, verify dimensions of other construction by field measurements before proceeding with the work.
- F. Environmental Limitations: Do not install Stabilized Aggregate pathway during rainy conditions or below 40 degrees Fahrenheit and falling.

1.12 EXCAVATING AND GRADING AROUND UTILITIES

- A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.
- B. Determine location of underground utilities and perform work in a manner that will avoid damage. Hand excavate as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.
- C. Notification of the utility locate services is required for all Excavation and grading deeper than 12 inches: The Contractor is responsible for knowing the location and avoiding utilities that are not covered by the local utility locator service.

1.13 OBSERVATION OF THE WORK

- A. The Landscape Architect may observe the work at any time. They may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting specifications shall be paid by the Contractor.
- B. The Landscape Architect shall be informed of the progress of the work so the work may be observed during key times in the construction process. The Landscape Architect shall be afforded sufficient time to schedule visits to the site. Failure of the Landscape Architect to

make field observations shall not relieve the Contractor from meeting all the requirements of this specification.

1.14 FIRST WORK IN PLACE

- A. The Landscape Architect shall be informed once the first work in place has been completed for all individual elements included in this section for review to ensure the work is proceeding in accordance with the approved samples and mockups and per the Contract Documents. The Landscape Architect shall be afforded sufficient time to schedule visits to the site for review. In the event that sufficient time cannot be provided the Contractor shall provide images from multiple angles and perspectives of the work for Landscape Architect review.

1.15 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Warranty: Submit a written warranty executed by the installer agreeing to repair or replace components of Stabilized Aggregate that fail in materials or workmanship within the specified warranty period. Stabilizer Solutions, Inc. does not warranty “Stabilizer®” purchased from a non-approved Stabilizer Solutions, Inc. licensee. 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. Failure of system to meet performance requirements.
- C. Warranty Period: Contractor shall provide warranty for performance of product. Contractor shall warranty installation of product for the time of one year from completion.
- D. Contractor shall provide, for a period of sixty days, unconditional maintenance and repairs as required.

1.16 MAINTENANCE SERVICE

- A. Contractor to provide standard industry maintenance on all scope items herein until Final Acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Stabilizer® for Stabilized Aggregate surfaces provided by the following manufacturer:

1. Stabilizer Solutions, Inc. 33 South 28th St., Phoenix, AZ 85034; phone (602) 225-5900, (800) 336-2468; fax (602) 225-5902; website stabilizersolutions.com; email info@stabilizersolutions.com

B. Aggregates provided by the following manufacturer:

1. Kafka Granite. 550 East Highway 153, Mosinee, WI 54455. Phone (715) 687-2423; fax (715) 687-2395; Rep: Dan Steidl, Cell: 715-316-3956, email dan@kafkagranite.com

2.2 MATERIALS

A. Decomposed Granite or 3/8” or 1/4” crushed aggregate screenings

1. Sand and crushed stone shall consist of inert materials that are hard and durable, with stone free from surface coatings and deleterious materials. Gradation requirements shall be as follows:
2. Crushed Stone Sieve Analysis Percentage of Weight Passing a Square Mesh Sieve AASHTO T11-82 and T2782

1/4" MINUS AGGREGATE GRADATION

U.S. Sieve No.	Percent Passing by Weight
# 3/8"	100
# 4	90 – 100
# 8	75 – 80
# 16	55 – 65
# 30	40 – 50
# 50	25 – 35
# 100	15 – 20
# 200 to	10 – 15

3. Acceptable local supplier list to be provided by Landscape Architect
4. Aggregate Color: SEE SCHEDULE.

B. Stabilizer® Binder

1. Patented, non-toxic, organic binder that is a colorless and odorless concentrated powder that binds decomposed granite or crushed 3/8” or 1/4” minus aggregate.
2. Product to have 64% pre-consumer recycled content.
3. Product shall have 25 years OF experience at same formulation.

2.3 AUXILIARY MATERIALS

- A. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.
- B. Sand: ASTM D 1073 or AASHTO M 29, Grade No. 2 or No. 3.
- C. Paving Geotextile: AASHTO M 288 paving fabric; nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications. See Section 31 32 19, "Geosynthetic Soil Stabilization and Layer Separation."

2.4 EXCESS MATERIALS

- A. Provide owner's authorized rep. with the following excess materials for use in future Stabilized Aggregate repair: 40 to 50 lb. Bags of the Stabilized Aggregate blended with proper amount of Stabilizer®.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Prior to installation examine site to confirm that existing conditions are satisfactory for the work of this section to proceed.
- B. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope toward the under drain lines as shown on the drawings.
- C. Confirm that no adverse drainage conditions are present.
- D. Confirm that no conditions are present which are detrimental to plant growth.
- E. Confirm that utility work has been completed per the drawings.
- F. If unsatisfactory conditions are encountered, notify the Landscape Architect immediately to determine corrective action prior to proceeding.

3.2 PREPARATION

- A. Base shall be 3" compacted layer of your state's DOT recommended crushed granular road base. Make any corrections necessary to base furnished and installed to bring gravel to the elevations shown on the drawing.
- B. Pre-soak base material with water and compact to 95% determined by Test Method ASTM D 1557 prior to installing Stabilized Aggregate. Compaction testing to be provided by project owner, one test per 2,000 square feet of base.

- C. Although porous, it is recommended to have proper drainage available to ensure no standing water on surface or adjacent to Stabilized Aggregate, including downspouts when placed under roof overhang and surface drains. Before proceeding with installation, notify Owner's Representative in writing of unsuitable site/base conditions.

3.3 COORDINATION WITH PROJECT WORK

- A. The Contractor is responsible for investigating, and being aware of, the work requirements of their sub-contractors and other contractors. The Contractor shall coordinate with all other work that may impact the completion of the work herein.
- B. Prior to the start of work, prepare a detailed schedule of the work for coordination with other trades.

3.4 BLENDING STABILIZER

- A. Stabilizer® shall be thoroughly pre-mixed with aggregate at the rate of 15-lbs of Stabilizer® per 1-ton of aggregate. Verify with manufacturer correct Stabilizer® rate for your project and climate. Drop spreading of Stabilizer® over pre-placed aggregate or mixing by rototilling is not acceptable. Stabilizer shall be mechanically pre-mixed per manufacturer's recommendations using an approved mechanical blending unit to adequately blend Stabilizer® with aggregate (Bucket blending is not an approved blending apparatus). Always blend Stabilizer® and aggregate DRY.

3.5 PLACEMENT

- A. After pre-blending, place Stabilized Aggregate directly on prepared sub-grade. Level to desired grade and cross section. Depth of pathways shall be 3" for heavy foot traffic and light vehicles. DO NOT place on filter fabric. Contact Stabilizer Solutions, Inc. for installation on slopes greater than 8%.

3.6 WATERING

- A. Water heavily for full-depth moisture penetration of profile. Water activates Stabilizer®. Apply 25 to 45- gallons of water per 1-ton to achieve saturation. Randomly test for depth using a probing device, which reaches full depth.
- B. Contractor shall wait a minimum of 6 – 72 hours or until such time that the Stabilized Aggregate is able to accept compaction from a 1 to 5 ton roller without separation, plowing or any other physical compromise of the aggregate.
- C. If surface aggregate dries significantly quicker than subsurface material, lightly mist surface before compaction.

3.7 COMPACTION

- A. Compact Stabilized Aggregate to 85% relative compaction by equipment such as; a 2 to 5-ton double drum roller making 3 to 4 passes. Do not begin compaction for 6 hours after placement and up to 72 hours. DO NOT use a vibratory plate compactor or vibration feature on roller, as vibration separates large aggregate particles. If pumping or pancaking of surface occurs, surface is still too wet to roll.
- B. Take care in compacting surface when adjacent to planting and irrigation systems, use 8" or 10" hand tamp. Installation of Stabilized Aggregate more than 3" thick shall be installed in lifts. If 4" thick compacted (2) 2" lifts. If 5" thick compacted (2) 2.5" lifts. If Stabilized Aggregate is pre-moistened before installation entire 4" or 5" lift may be installed.
- C. Lightly spray surface area following compaction. Do not disturb aggregate surface with spray action.

3.8 INSPECTION

- A. Finished surface shall be smooth, uniform and solid with no evidence of chipping or cracking. Cured and compacted pathway shall be firm throughout profile with no spongy areas. Loose material shall not be present on surface after installation, but may appear after use and according to environmental conditions. Pathway shall remain stable underneath loose granite on top with a "natural" look. Any significant irregularities in path surface shall be repaired to the uniformity of entire installation.

3.9 REPAIR AND REPLACEMENT

- A. General: Repair or replace that is damaged by construction operations, in a manner approved by Landscape Architect.

3.10 WASTE HANDLING

- A. General: Handle waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

3.11 CLEANING

- A. The contractor should clean the job site and remove any excess materials. Coordinate with Owner for storage locations for any Attic Stock materials where applicable.

3.12 PROTECTION

- A. Contractor shall furnish and install construction fence around new surface to prevent public access. Fencing shall be maintained in place for a minimum of 12 - 72 hours after

completion of installation, or as directed by the Owner' Representative. Drying period may take longer due to weather conditions.

- B. Contractor shall notify Owner's Representative that landscape irrigation shall be restricted near Stabilized Aggregate surface until drying period is complete. Standing water on surface and adjacent to path shall be restricted at all times.

3.13 MAINTENANCE

- A. Remove debris, such as paper, grass clippings, or organic material by mechanically blowing or hand raking as needed. When plowing snow, use rubber baffle on plow blade or wheels on plow to lift blade 1/4" off the surface.
- B. During first year, minor amounts of loose aggregate may appear on surface (1/16 to 1/4"). If material exceeds a 1/4", redistribute over entire surface. Water to 1" depth and compact with power roller of no less than 1000-lbs. Repeat as needed. If cracking occurs, sweep fines into cracks, water thoroughly and hand tamp with an 8" – 10" hand tamp.

3.14 MAINTENANCE SERVICE

- A. Maintenance Service: Provide maintenance by skilled employees of Installer or approved Subcontractor. Maintain as required in "Maintenance" Article. Begin maintenance immediately after scope is installed and continue until final acceptance.

3.15 REPAIRS

- A. Excavate damaged area to the depth of the Stabilized Aggregate and square off sidewalls.
- B. If area is dry, moisten damaged portion lightly.
- C. Pre-blend the dry required amount of Stabilizer® with the proper amount of aggregate in a concrete mixer.
- D. Add water to the pre-blended Stabilized Aggregate. Thoroughly moisten mix with 25 to 45 gallons per 1-ton of pre-blended material or to approximately 10% moisture content.
- E. Apply moistened pre-blended Stabilized Aggregate to excavated area to finish grade.
- F. Compact with an 8" to 10" hand tamp or 250 to 300 pound roller. Keep traffic off areas for 12 to 48 hours after repair has been completed.

3.16 DEMONSTRATION AND TRAINING

- A. Engage a manufacturer-authorized service representative and/or other authorized professional to train Owner's maintenance personnel to adjust and operate all components herein.

- B. Train Owner's maintenance personnel in proper maintenance procedures for all components herein.

END OF SECTION - 32 15 43

SECTION 32 15 50 – METAL EDGING

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. Metal edging for straight-line and curvilinear borders along edges of walkways, turf and planting beds, SEE SCHEDULE.

- B. Related Requirements:

- 1. Section 32 14 00 "Unit Paving."
- 2. Section 32 15 43 "Stabilized Aggregate Paving."
- 3. Section 32 92 00 "Turf and Grasses".
- 4. Section 32 93 00 "Plants".

1.3 PERMITS AND FEES

- A. Permits: The Contractor shall secure and pay for all permits, inspections, and certificates of inspection of any governmental and inspection body having jurisdiction over all or any part of the work included under this section and/or such inspections etc., required by these specifications.

- B. Fees: The Contractor shall secure and pay for all fees and assessments in connection with the work under this contract and shall include this cost in its bid and contract price.

1.4 PREINSTALLATION MEETINGS

- A. Pre-installation Meeting: Conduct meeting at Project Site, Manufacturer's Facility of Fabricator's Shop. Confirm with Owner and Landscape Architect 14 days prior to conference.

- 1. Before submitting submittals, review submittals, mockup and other requirements of this section and examine procedures for ensuring quality of the scope herein. Require representatives of each entity directly concerned with the scope herein, including but not limited to, the following:
 - a. Contractor's superintendent.
 - b. Subcontractor.

- c. Special Subcontractor.
 - d. Independent testing agency responsible for testing.
 - e. Product manufacturer and/or local representative.
 - f. Authority Having Jurisdiction.
 - g. Landscape Architect.
2. Review methods and procedures related to the work of this section, including but not limited to, the following:
- a. Responsibilities of each party.
 - b. Coordination of Landscape Architect's review of the work, including but not limited to:
 - 1) Site or Shop Visits to Review Samples and Mockups
 - 2) Site Visits to Observe General Construction Progress
 - 3) Site or Shop Visits to Review Fabrication Progress
 - 4) Site Visits to Review First Work In Place
 - 5) Site Visits for Punch List Review
 - 6) Site Visits for Punch List Completion Review
 - 7) Site Visit for Warranty Review
 - c. Lines of authority and communication for the project. Procedures for resolution of any project document ambiguity.
 - d. Methods for documenting, reporting, and distributing documents and reports.
 - e. Proposed sources of materials.
 - f. Procedures for packaging and storing archive samples.
 - g. Review of the time schedule for all installation and testing. Schedule of workdays and/or starting times if third party testing verification is required.
 - h. Quality control.
 - i. Temperature and weather limitations. Installation procedures for adverse weather conditions. Defining acceptable subgrade or ambient moisture and temperature conditions for working during installation.
 - j. Subgrade conditions, dewatering responsibilities, and subgrade maintenance plan.
 - k. Deployment techniques including allowable subgrade conditions.
 - l. Construction, material placement, and backfilling.
 - m. Requirements for protecting work, including restriction of traffic and adjacent work impacting during installation period and for remainder of construction period.
 - n. Measurement and payment schedules.
 - o. Health and safety.
 - p. Procedures and responsibilities for preparation and submission of as-built drawings.

1.5 COORDINATION

- A. Refer to Division 1 Requirements.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product submit the following:

1. Manufacturer's Product Literature and Specification Data.
 2. Manufacturer's written instructions for recommended maintenance practices.
 3. Color and finish samples for verification and selection.
 4. Written manufacturer's warranty.
 5. Product liability insurance certificate with project owner as certificate holder.
 6. MSDS for items in Part 2 "Products."
- B. Samples for Initial Selection: Standard manufacturer's and/or fabricator's samples of each type of product, material, ingredient, admixture, finish, and/or color requiring selection.
- C. Samples for Verification: For each type of selection made above provide a final sample.
- D. Shop Drawings: Prepared by or under the supervision of a qualified professional, detailing fabrication and assembly.
1. Submit shop drawings within a reasonable time so as not to delay the start of material fabrication and installation.
 2. Submit shop drawings per above allowing a minimum review time of 10 business days for review and response. Per above, also allow enough time for revisions and resubmittal where reasonably predictable.
 3. Shop drawings shall show the proposed layout identifying all components and details based on field verified conditions and measurements.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, Fabricator, Manufacturer and Testing agency.
- B. Material Certificates: For each of the following, signed by manufacturers:
1. For all materials.
- C. Material Test Reports: For the following, from a qualified testing agency:
1. For all materials.
- D. Preconstruction test reports.
- E. Source quality-control test reports.
- A. Field quality-control and special inspection reports.
- B. Minutes of pre-installation conference.
- C. Maintenance Instructions.
- D. Warranty: Written manufacturer's warranty.

1.8 CLOSEOUT SUBMITTALS

- A. Maintenance Data: From Installer including a recommended maintenance plan with procedures for inspection and care during a calendar year. Submit before start of required warranty and maintenance periods

1.9 MAINTENANCE MATERIAL SUBMITTALS

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

1.10 QUALITY ASSURANCE

- A. Illinois Accessibility Code: Do not exceed longitudinal slope of 1:20 (5%) or cross-slope of 1:50 (2%) for new walkways. New walkways shall be sloped to meet existing walkway.
- B. Americans with Disabilities Act: Comply with all current rules and regulations as set forth in the Americans with Disabilities Act.
- C. Manufacturer Qualifications: A metal edging manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located.
- D. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.
- E. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of authorities having jurisdiction for metal edging work.
- F. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockups of full-sized components to demonstrate typical finish, texture, and color; and standard of workmanship.
 - 2. Build mockups of metal edging in the location and of the size indicated or, if not indicated, build mockups where directed by the Landscape Architect and not less than 120 inches (3048 mm) long. Include examples of all conditions.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Landscape Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
 - 5. Mockups to be retained on site or at approved location by Owner and Landscape Architect until all related work scope is deemed Substantially Complete.
 - 6. Contractor to rework mockups as necessary until mockups are accepted.

1.11 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on aggregate paving mixtures.

1.12 DELIVERY STORAGE AND HANDLING

- A. Deliver packaged products in an undamaged condition in original containers, displaying manufacturer's labels, along with instructions for handling, storing, unpacking, protecting, and installing.
- B. Deliver and store materials in manufacturer's original containers, with seals unbroken and identification labels intact until time of use.
- C. Deliver products to achieve the shortest duration of storage time as practicable.
- D. Deliver all chemical products in original, unopened containers with original labels intact and legible, which state the guaranteed chemical analysis. Store all chemicals in weather protected enclosure.
- E. Comply with manufacturer's written instructions for delivery, storage, and handling, and as required to prevent damage to products and work during construction.
- F. Store products and materials in a neat and orderly manner. Maintain clear aisles and access to work areas. Protect stored products from theft and damage. Store products above ground in weathertight, ventilated packaging or enclosures.
- G. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.
- H. Store liquids in tightly closed containers protected from freezing.
- I. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- J. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk materials with appropriate certificates.

1.13 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of all site elements and other construction contiguous with the work of this section prior to fabrication and/or installation.
- B. The work shall not occur in the presence of standing water, mud, snow, or frozen subgrade conditions. Work shall not occur while precipitation is occurring or during excessive winds, or when temperatures are outside the limits specified in this specification. Work completed during these conditions will be rejected.
- C. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements.

1.14 EXCAVATING AND GRADING AROUND UTILITIES

- A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.
- B. Determine location of underground utilities and perform work in a manner that will avoid damage. Hand excavate as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.
- C. Notification of the utility locate services is required for all Excavation and grading deeper than 12 inches: The Contractor is responsible for knowing the location and avoiding utilities that are not covered by the local utility locator service.

1.15 OBSERVATION OF THE WORK

- A. The Landscape Architect may observe the work at any time. They may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting specifications shall be paid by the Contractor.
- B. The Landscape Architect shall be informed of the progress of the work so the work may be observed during key times in the construction process. The Landscape Architect shall be afforded sufficient time to schedule visits to the site. Failure of the Landscape Architect to make field observations shall not relieve the Contractor from meeting all the requirements of this specification.

1.16 FIRST WORK IN PLACE

- A. The Landscape Architect shall be informed once the first work in place has been completed for all individual elements included in this section for review to ensure the work is proceeding in accordance with the approved samples and mockups and per the Contract Documents. The Landscape Architect shall be afforded sufficient time to schedule visits to the site for review. In the event that sufficient time cannot be provided the Contractor shall provide images from multiple angles and perspectives of the work for Landscape Architect review.

1.17 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering and wear.
 - b. Separation or delamination of materials and components.
 - 2. Warranty Period: One year from date of Substantial Completion.

1.18 MAINTENANCE SERVICE

- A. Contractor to provide standard industry maintenance on all scope items herein until Final Acceptance.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. SEE SCHEDULE.

2.2 AUXILIARY MATERIALS

- A. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wetttable powder form.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Prior to installation examine site to confirm that existing conditions are satisfactory for the work of this section to proceed.

- B. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope toward the under drain lines as shown on the drawings.
- C. Confirm that no adverse drainage conditions are present.
- D. Confirm that no conditions are present which are detrimental to plant growth.
- E. Confirm that utility work has been completed per the drawings.
- F. If unsatisfactory conditions are encountered, notify the Landscape Architect immediately to determine corrective action prior to proceeding.

3.2 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to begin installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 SURFACE PREPARATION

- A. Ensure that all underground utility lines are located and will not interfere with the proposed edging installation before beginning work.
- B. Locate border line of edging with string or other means to assure border straightness and curves as designed. Landscape Architect to approve layout prior to installation of edging. Notify Landscape Architect a minimum of 5 business days prior to layout.
- C. Dig trench 1 inch (25 mm) deeper than set of edging bottom.
- D. General: Immediately before placing materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive material.
- E. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

3.4 COORDINATION WITH PROJECT WORK

- A. The Contractor is responsible for investigating, and being aware of, the work requirements of their sub-contractors and other contractors. The Contractor shall coordinate with all other work that may impact the completion of the work herein.
- B. Prior to the start of work, prepare a detailed schedule of the work for coordination with other trades.

3.5 METAL EDGING INSTALLATION

- A. Set edging into trench with top flush to thatch level of turf side with side having loops for stakes placed on opposite side of turf (or on turf/planting side for maintenance strip).
- B. Securely connect sections together in accordance with manufacturer's instructions. Drive stakes through edging loops with spacing in accordance with manufacturer's recommendations until locked into edging with stake top 1/8 inch (3.175 mm) below top of edging. Provide additional stakes, longer stakes, heavier gauge stakes, or any combination of previously mentioned as necessary to firmly secure edging for permanent intended use.
- C. Where edging sections turn at corners and at angled runs, cut edging partially up through its height from bottom and turn back to desired angle to form rounded exposed radius.
- D. Backfill both sides of edging, confirm and adjust if necessary that sections are securely held together, and compact backfill material along edging to provide top of edging flush with finished grade.

3.6 GRADE, ELEVATION AND ALIGNMENT CONTROL

- A. Provide grade and elevation control during installation of the work of this section. Utilize grade stakes, string lines, surveying equipment, and other means and methods to assure that grades and contours conform to the grades indicated on the plans.
- B. Provide alignment control during installation of the work of this section. Utilize stakes, pins, marking techniques, string lines, surveying equipment, and other means and methods to assure that alignments conform to the alignments on the plans.

3.7 INSTALLATION TOLERANCES

- A. Ensure metal edging meets or exceeds the following tolerances:
 - 1. Top Elevation: Plus or minus 1/8 inch (3.175 mm) of grades shown in grading plan. Ensure smooth transitions.
 - 2. Horizontal Alignment: Plus or minus 1/4 inch (6.35 mm) over 10 linear feet of run. Ensure smooth transitions.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

3.9 REPAIR AND REPLACEMENT

- A. General: Repair or replace that is damaged by construction operations, in a manner approved by Landscape Architect.

3.10 WASTE HANDLING

- A. General: Handle paving waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

3.11 CLEANING

- A. The contractor should clean the job site and remove any excess materials. Coordinate with Owner for storage locations for any Attic Stock materials where applicable.

3.12 PROTECTION

- A. Contractor shall furnish and install construction fence around new installations to prevent access. Fencing shall be maintained in place for a minimum of 48 hours after completion of installation, or as directed by the Landscape Architect. Drying period may take longer due to weather conditions.
- B. Contractor shall notify Landscape Architect that landscape irrigation shall be restricted near installations until applicable drying period is complete. Standing water on installations shall be restricted at all times.
- C. Protect installed work from disturbance or damage from construction operations. Maintain metal edging throughout construction period until Substantial Completion.
- D. Make repairs to installed work if disturbed or damage, and restore areas to new conditions.

3.13 MAINTENANCE SERVICE

- A. Maintenance Service: Provide maintenance by skilled employees of Installer or approved Subcontractor. Maintain as required in "Maintenance" Article. Begin maintenance immediately after scope is installed and continue until final acceptance.

3.14 DEMONSTRATION AND TRAINING

- A. Engage a manufacturer-authorized service representative and/or other authorized professional to train Owner's maintenance personnel to adjust and operate all components herein.
- B. Train Owner's maintenance personnel in proper maintenance procedures for all components herein.

END OF SECTION – 32 15 50

SECTION 32 31 19 - METAL FENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal Fences.
- B. Related Requirements:
 - 1. Section 03 30 01 Cast-In-Place Concrete

1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM), Fifth edition.
- B. ASTM-A82: Cold Drawn steel wire, Plain, for Concrete Reinforcement.
- C. ASTM-A185: Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
- D. A123/A123M-02 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- E. A 641 (1989) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
- F. A1008 Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy (HSLA) and HSLA with Improved Formability
- G. A787-01 Standard Specification for Electric-Resistance-Welded Metallic-Coated Carbon Steel Mechanical Tubing
- H. A513-00 Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
- I. A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- J. A500 (1993) Standard Specification for Cold formed welded and seamless carbon steel structural tubing in round shapes.

- K. B 6 (1987) Standard Specification for Zinc
- L. B 117 (1990) Standard Test Method of Salt Spray (Fog) Testing.
- M. B 221 (1995) Standard Specification for Aluminum and aluminum-alloy extruded bars, rods, wire, shapes and tubes.
- N. D 2247 (1988) Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
- O. D 2794 (1990) Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
- P. D 3359 (1990) Standard Test Methods for Measuring Adhesion by Tape.
- Q. F 900 (1984) Standard Specification for industrial and commercial swing gates.
- R. F 934 (1989) Standard Specification for Standard Colors for Polymer-Coated Chain Link Fence Materials.
- S. F 1184 (1988) Standard Specification for industrial and commercial horizontal slide gates.
- T. F 1043-11A Standard Specification for Strength and Protective Coatings on Steel Industrial Chain Link Fence Framework
- U. F2919 Standard Specification for Welded Wire Mesh Fence Fabric (Metallic-Coated or Polymer Coated) with Variable Mesh Patterns or Meshes Greater than 6 sq. in. [3871 mm²] in Panels
- V. A121 Standard Specification for Metallic-Coated Carbon Steel Barbed Wire
- W. F626 Standard Specification for Fence Fittings

1.2 PRE-INSTALLATION MEETINGS

- A. Pre-installation Meeting: Conduct meeting at Project Site, Manufacturer's Facility of Fabricator's Shop. Confirm with Owner and Landscape Architect 14 days prior to conference.
 - 1. Before submitting submittals, review submittals, mockup and other requirements of this section and examine procedures for ensuring quality of the scope herein. Require representatives of each entity directly concerned with the scope herein, including but not limited to, the following:
 - a. Contractor's superintendent.
 - b. Subcontractor.
 - c. Special Subcontractor.
 - d. Product manufacturer and/or local representative.
 - e. Landscape Architect.

2. Review methods and procedures related to the work of this section, including but not limited to, the following:
 - a. Responsibilities of each party.
 - b. Coordination of Landscape Architect's review of the work, including but not limited to:
 - 1) Site or Shop Visits to Review Samples and Mockups
 - 2) Site Visits to Observe General Construction Progress
 - 3) Site or Shop Visits to Review Fabrication Progress
 - 4) Site Visits to Review First Work In Place
 - 5) Site Visits for Punch List Review
 - 6) Site Visits for Punch List Completion Review
 - 7) Site Visit for Warranty Review
 - c. Lines of authority and communication for the project. Procedures for resolution of any project document ambiguity.
 - d. Methods for documenting, reporting, and distributing documents and reports.
 - e. Proposed sources of materials.
 - f. Procedures for packaging and storing archive samples.
 - g. Review of the time schedule for all installation and testing. Schedule of workdays and/or starting times if third party testing verification is required.
 - h. Quality control.
 - i. Temperature and weather limitations. Installation procedures for adverse weather conditions. Defining acceptable subgrade or ambient moisture and temperature conditions for working during installation.
 - j. Subgrade conditions, dewatering responsibilities, and subgrade maintenance plan.
 - k. Deployment techniques including allowable subgrade conditions.
 - l. Construction, material placement, and backfilling.
 - m. Requirements for protecting work, including restriction of traffic and adjacent work impacting during installation period and for remainder of construction period.
 - n. Measurement and payment schedules.
 - o. Health and safety.
 - p. Procedures and responsibilities for preparation and submission of as-built drawings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Manufacturer's Product Literature and Specification Data.
2. Manufacturer's written instructions for recommended maintenance practices.
3. Color and finish samples for verification and selection.
4. Written manufacturer's warranty.
5. Product liability insurance certificate with project owner as certificate holder.
6. MSDS for items in Part 2 "Products."
7. Include technical data and tested physical and performance properties.
8. Fence and gate posts, rails, and fittings.
9. Gates and hardware.
10. Gate operators, including operating instructions.
11. Motors: Show nameplate data, ratings, characteristics, and mounting arrangements.

- B. Samples for Initial Selection: Manufacturer's color charts shown on its internet site.
- C. Samples for Verification: Request a color chip from the manufacturer.
- D. Shop Drawings: Show locations of fence, each gate, posts, rails, and details of gate swing, or other operation, hardware, and accessories. Indicate materials, dimensions, sizes, weights, and finishes of components. Include plans, elevations, sections, gate swing and other required installation and operational clearances, and details of post anchorage, attachment and bracing. Installation procedures and instructions by manufacturer describing all details for a typical fence and gates.
 - 1. Submit shop drawings within a reasonable time so as not to delay the start of material fabrication and installation.
 - 2. Submit shop drawings per above allowing a minimum review time of 10 business days for review and response. Per above, also allow enough time for revisions and resubmittal where reasonably predictable.
 - 3. Shop drawings shall show the proposed layout identifying all components and details based on field verified conditions and measurements.

1.1 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer and testing agency.
- B. Maintenance Data: Request the maintenance manual for the gate operator.
- E. Preconstruction test reports.
- F. Source quality-control test reports.
- A. Field quality-control and special inspection reports.
- B. Minutes of pre-installation conference.
- C. Maintenance Instructions.
- D. Warranty: Written manufacturer's warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data.

1.3 SUBSTITUTE PRODUCTS

- A. To enable all tenders to be judged equitably, they shall be based on the specified products in this document and shown on the drawings:
- B. The proposal for any substitute products must be attached to their tender separately, identifying the substitute product by its trade name along with any savings it may represent.

- C. Following the opening of the tender, only those substitutes proposed by the lowest bidder of the specified products will be considered.
- D. All substitute approval requests shall be accompanied by manufacturing drawings and specifications, and they meet all specifications for design, size gauge of metal parts and fabrication.
- E. Each substitute sample must be presented to the owner/consultant within seven days following the opening of tenders. After this time, the bidder will be required to supply the original specified product.
- F. The owner/consultant reserves the right to grant or deny approval for proposed substitutions without prejudice to this rights and his decision shall be final.
- G. The above conditions apply to this section independently of any other clauses on the subject found in this document.

1.5 QUALITY ASSURANCE

- A. Contractor shall establish and maintain a quality assurance program for the purposes of managing the quality of the work. Quality assurance program shall consist of plans, procedures and organizational design necessary to ensure that work of this Section meets the prescriptive and performance requirements specified. The Quality Control, Source Quality Control and Site Quality Control provisions specified elsewhere in this Section shall form part of the Quality Assurance Program.
- B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of <Insert applicable standards> of Authorities Having Jurisdiction for all work included in this section.
 - 1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.
- C. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.
- D. Codes and Standards: Conform work to all applicable codes and standards.
- E. Manufacturer Qualifications: Provide manufacturer qualifications as follows:
 - 1. Submit a list of ten completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.
 - 2. Submit qualifications of manufacturer.
 - 3. Submit manufacturer's quality control program.
 - 4. Submit example of Material Warranty and any other applicable warranties.
- F. Installer Qualifications: Provide installer qualifications as follows:

1. Installer Qualifications: an experienced installer who has completed fences and gates similar in material, design, and extent to those indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
 2. Submit a list of ten completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.
 3. Submit resumes and/or qualifications of installation manager(s).
 4. Submit fabrication quality control program.
 5. Submit installation quality control program.
 6. Submit example of Material Warranty and any other applicable warranties.
- G. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified for testing indicated. Provide testing agency qualification as follows:
1. Qualified according to ASTM D 3666 for testing indicated.
 2. Submit a list of ten completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.
 3. Submit resumes and/or qualifications of testing manager(s).
 4. Submit testing quality control program.
 5. Submit example of Material Warranty and any other applicable warranties.
- H. Mockups: Provide mockup for each type of component per the Drawings and/or shop drawing.
1. Build mockups of full-profile sections to demonstrate including but not limited to overall material quality, typical joints; typical transitions, surface finish, surface texture, color; and standard of workmanship.
 2. Build mockups in the location and of the size indicated. Build mockups where directed by Landscape Architect.
 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Landscape Architect specifically approves such deviations in writing.
 4. Subject to compliance with requirements, approved mockups may not become part of the completed work.
 5. Mockups to be retained on site or at approved location by Owner and Landscape Architect until all related work scope is deemed Substantially Complete.
 6. Contractor to rework mockups as necessary until mockups are accepted.
- I. Source Limitations for Fences and Gates: obtain each color, grade, finish, type, and variety of components for fences and gates from one source with resources to provide fences and gates of consistent quality in appearance and physical properties.
- J. Electrical Components, Devices, and Accessories: listed and labelled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- K. UL Standard: Provide gate operators that comply with UL 325.
- L. Emergency Access Requirements: comply with requirements of authorities having jurisdiction for automatic gate operators serving as a required means of access.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver packaged products in an undamaged condition in original containers, displaying manufacturer's labels, along with instructions for handling, storing, unpacking, protecting, and installing.
- B. Deliver and store materials in manufacturer's original containers, with seals unbroken and identification labels intact until time of use.
- C. Deliver products to achieve the shortest duration of storage time as practicable.
- D. Deliver all chemical products in original, unopened containers with original labels intact and legible, which state the guaranteed chemical analysis. Store all chemicals in weather protected enclosure.
- E. Comply with manufacturer's written instructions for delivery, storage, and handling, and as required to prevent damage to products and work during construction.
- F. Store products and materials in a neat and orderly manner. Maintain clear aisles and access to work areas. Protect stored products from theft and damage. Store products above ground in weathertight, ventilated packaging or enclosures.
- G. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.
- H. Store liquids in tightly closed containers protected from freezing.
- I. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- J. 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 materials with appropriate certificates.

1.4 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of all site elements and other construction contiguous with the work of this section prior to fabrication and/or installation.
- B. The work shall not occur in the presence of standing water, mud, snow, or frozen subgrade conditions. Work shall not occur while precipitation is occurring or during excessive winds, or

when temperatures are outside the limits specified in this specification. Work completed during these conditions will be rejected.

- C. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements.
- F. Existing Utilities: do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect not less than [two] <Insert number> days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.
- G. Field Measurements: verify layout information for fences and gates shown on drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.7 EXCAVATING AND GRADING AROUND UTILITIES

- A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.
- B. Determine location of underground utilities and perform work in a manner that will avoid damage. Hand excavate as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.
- C. Notification of the utility locate services is required for all Excavation and grading deeper than 12 inches: The Contractor is responsible for knowing the location and avoiding utilities that are not covered by the local utility locator service.

1.8 OBSERVATION OF THE WORK

- A. The Landscape Architect may observe the work at any time. They may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting specifications shall be paid by the Contractor.
- B. The Landscape Architect shall be informed of the progress of the work so the work may be observed during key times in the construction process. The Landscape Architect shall be afforded sufficient time to schedule visits to the site. Failure of the Landscape Architect to make field observations shall not relieve the Contractor from meeting all the requirements of this specification.

1.9 FIRST WORK IN PLACE

- A. The Landscape Architect shall be informed once the first work in place has been completed for all individual elements included in this section for review to ensure the work is proceeding in accordance with the approved samples and mockups and per the Contract Documents. The Landscape Architect shall be afforded sufficient time to schedule visits to the site for review. In the event that sufficient time cannot be provided the Contractor shall provide images from multiple angles and perspectives of the work for Landscape Architect review.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering and wear.
 - b. Separation or delamination of materials and components.
 - 2. Warranty Period: One years from date of Substantial Completion.

1.11 MAINTENANCE SERVICE

- A. Contractor to provide standard industry maintenance on all scope items herein until Final Acceptance.

PART 2 - GENERAL

2.1 MANUFACTURER

- A. SEE SCHEDULE.

PART 3 - EXECUTION

3.1 INSPECTION

- B. Prior to installation examine site to confirm that existing conditions are satisfactory for the work of this section to proceed.
- C. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope toward the under drain lines as shown on the drawings.
- D. Confirm that no adverse drainage conditions are present.
- E. Confirm that no conditions are present which are detrimental to plant growth.

- F. Confirm that utility work has been completed per the drawings.
- G. If unsatisfactory conditions are encountered, notify the Landscape Architect immediately to determine corrective action prior to proceeding.
- H. Examine areas and conditions, with Installer present, for compliance with requirements for [a verified survey of property lines and legal boundaries,] site clearing, earthwork, pavement work, and other conditions affecting performance.
 - 1. Do not begin installation before final grading is completed, unless otherwise permitted by Architect.
- I. 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 ft. (152.5 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 COORDINATION WITH PROJECT WORK

- A. The Contractor is responsible for investigating, and being aware of, the work requirements of their sub-contractors and other contractors. The Contractor shall coordinate with all other work that may impact the completion of the work herein.
- B. Prior to the start of work, prepare a detailed schedule of the work for coordination with other trades.

3.4 INSTALLATION GENERAL

- A. Install fencing on established boundary lines inside property line
- B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacing indicated, in firm, undisturbed or compacted soil.
- C. Post Setting: Set posts in concrete footing. Protect portion of posts above ground from concrete splatter. Place concrete around posts and consolidation. Using mechanical devices to set posts is not permitted. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during placement and finishing operations until concrete is sufficiently cured.
 - 2. Dimensions and Profile: As indicated on Drawings.
 - 3. Space line posts uniformly at center to center.
 - 4. Exposed Concrete Footings: Extend concrete 2 in. (50 mm) above grade, smooth, and shape to shed water.
 - 5. Concealed Concrete Footings: Stop footings 2 in. (50 mm) <Insert dimension> below grade [as indicated on Drawings] to allow covering with surface material.

6. Posts Set into Concrete in Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with [non shrink, non-metallic grout,] [anchoring cement,] mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.
7. Posts Set into Concrete in Voids: Form or core drill holes not less than 5 in. (125 mm) deep and $\frac{3}{4}$ in. (20 mm) larger than OD of post. Clean holes of loose material, insert posts, and fill granular space between post and concrete with [non shrink, non-metallic grout,] [anchoring cement,] mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.
8. Flange Post Installation: Bolt mounting plates attached to each post to slab or structure as indicated, using expansion bolts.

3.5 FENCE INSTALLATION – Model ELITE

- A. Terminal Posts: Locate terminal end, corner, and gate posts at changes in horizontal or vertical alignment of [15 degrees or more] [30 degrees or more] [as indicated on Drawings] <Insert requirement>.
- B. Square post installation 2 in. or 3 in. (50 mm or 75 mm): Post hole shall be a minimum of 8 in. (200 mm) in diameter and 42 in. (1070 mm) in depth. Once the concrete is set, the mesh sections are installed with the Universal Bracket kits 2 in. or 3 in. (50mm or 75 mm), always install flush with horizontal wire of the panel (no gap). Post spacing are for 2 in. (50mm) post 97-3/4 in. (2483 mm) c/c with an adjustment of $\pm 1\text{-}1/2$ in. (38 mm) and for the 3 in. (75mm) post 98-3/4 in. (2508 mm) c/c of the post with an adjustment of $\pm 1\text{-}1/2$ in. (38 mm) on each side.
- C. For the fence to follow slopes, it is required to step the fence sections. The Universal bracket on square posts can be slid along the post at the desired height and should always be install flush with horizontal wire (no gap).
- D. When faced with a steep slope, it will be necessary to order longer posts and panels cut in half as to keep the gap under the panel to a minimum.
- E. Mesh Panels: Vertical wire extensions [pointing up for security or down for safety]. The fence panel shall be installed a distance of a minimum of 1-1/4 in. (30 mm) and maximum of 2 in. (50 mm) above the ground surface.
- F. Upon cutting or trimming, a post or a wire mesh section, apply a zinc rich primer to the exposed ends and finish with the matching touch-up paint supplied by the manufacturer.

3.6 CAST-IN-PLACE CONCRETE

- A. General: Comply with ACI 301 for cast-in-place concrete.

- B. Materials: Portland cement complying with ASTM C 150 <Insert type if required>, aggregates complying with ASTM C 33, and potable water [for ready-mixed concrete complying with ASTM C 94]. [Measure, batch, and mix Project-site-mixed concrete according to ASTM C 94.]
 - 1. Concrete Mixture: Normal-weight concrete with not less than 3000 psi (20.7- Mpa) compressive strength (28 days), 3-inch (75-mm) slump, and contain " coarse aggregate " of a minimum diameter of 1/5 in. (5 mm) to a maximum of ¾ in. (20 mm) maximum size aggregate. A 5% to 7% air entrained or according to recommendation of section 03000.
- C. Materials: Dry-packaged concrete mix complying with ASTM C 387 for normal-weight concrete mixed with potable water according to manufacturer's written instructions.

3.7 GROUT AND ANCHORING CEMENT

- A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.
- B. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer for exterior applications.

3.8 GATE INSTALLATION & ADJUSTMENT

- A. Install gate posts in accordance with manufacturer's instructions.
- B. Concrete Set Gate Posts: Drill holes in firm, undisturbed or compacted soil. Holes shall have a diameter 4 times greater than outside dimension of post, and depths approximately 6 in. (152mm) deeper than frost level. Excavate deeper as required for adequate support in soft and loose soils, and for posts with heavy lateral loads. Set post bottom 36 inches (914mm) below surface when in firm, undisturbed soil. Place concrete around posts in a continuous pour, tamp for consolidation. Trowel finish around post and slope to direct water away from posts. Check each post for vertical and top alignment, and maintain in position during placement and finishing operations.
- C. Install gates perfectly horizontal and levelled (at junction), plumb, and secure for full opening without interference.
- D. Attach hardware so to have the nuts inside the property thus making the assembly tamper-proof which will prevent unauthorized removal. Install ground-set items in concrete for anchorage.
- E. Adjust hardware for smooth operation and lubricate where necessary to operate smoothly, easily, and quietly, free from 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.

3.9 GROUNDING AND BONDING (Indicative only. Consult local professional for proper design.)

- A. Fence Grounding: Install at maximum intervals of [1500 ft. (450 m)] <Insert a lesser distance where grounding resistance is high> except as follows:
1. Fences within 100 ft. (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of [750 ft. (225 m)]
 2. Gates and Other Fence Openings: Ground fence on each side of opening.
 3. Bond metal gates to gate posts.
 4. Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 in. (460 mm) below finished grade.
 5. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.
 6. Material Above Finished Grade: [Copper] [Aluminum].
 7. Material On or Below Finished Grade: Copper.
 8. Bonding Jumpers: Braided copper tape, 1 in. (25 mm) wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.
 9. Connectors and Ground Rods: Listed in UL 467.
 10. Connectors for Below-Grade Use: Exothermic welded type.
 11. Ground Rods: Copper-clad steel. Size: 5/8 in. by 96 in. (16 mm by 2400 mm).
- B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 ft. (45 m) on each side of crossing.
- C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2, unless otherwise indicated.
- D. Grounding Method: At each grounding location, drive a ground rod vertically until the top is 6 in. (150 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at the grounding location.
- E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.
- F. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
1. Use electroplated or hot-tin-coated materials to ensure high conductivity to make contact points closer in order of galvanic series.
 2. Make connections with clean, bare metal at points of contact.
 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

- G. Bonding to Lightning Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor complying with NFPA 780.

3.10 GRADE AND ELEVATION CONTROL

- A. Provide grade and elevation control during installation of the work of this section. Utilize grade stakes, surveying equipment, and other means and methods to assure that grades and contours conform to the grades indicated on the plans.

3.11 FIELD QUALITY CONTROL- GROUNDING (Indicative only. Consult local professional for proper design.)

- A. Ground-Resistance Testing Agency: [Owner will engage] [Engage] a qualified independent testing agency to perform field quality-control testing.
- B. Ground-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure ground resistance not less than two full days after last trace of precipitation, without soil having been 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 two-point method according to IEEE 81. Desired Maximum Grounding Resistance Value: 25 ohms. Excessive Ground Resistance: If resistance to ground exceeds desired value, notify Architect promptly. Include recommendations to reduce ground resistance and proposal to accomplish recommended work.
- C. Report: Prepare test reports, certified by testing agency, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results.

3.12 ADJUSTING (For gate operator only.)

- A. Gate: Adjust gate to operate smoothly, easily, and quietly, free from 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 [, gate operator,] and other moving parts.

3.13 REPAIR AND REPLACEMENT

- A. General: Repair or replace that is damaged by construction operations, in a manner approved by Landscape Architect.

3.14 WASTE HANDLING

- A. General: Handle waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

3.15 CLEANING

- A. The contractor should clean the job site and remove any excess materials. Coordinate with Owner for storage locations for any Attic Stock materials where applicable.

3.16 PROTECTION

- A. Contractor shall furnish and install construction fence around new installations to prevent access. Fencing shall be maintained in place for a minimum of 48 hours after completion of installation, or as directed by the Landscape Architect. Drying period may take longer due to weather conditions.
- B. Contractor shall notify Landscape Architect that landscape irrigation shall be restricted near installations until applicable drying period is complete. Standing water on installations shall be restricted at all times.

3.17 MAINTENANCE SERVICE

- A. Maintenance Service: Provide maintenance by skilled employees of Installer or approved Subcontractor. Maintain as required in "Maintenance" Article. Begin maintenance immediately after scope is installed and continue until final acceptance.
- B. Inspection
 - 1. A thorough visual inspection shall be done annually.
 - 2. This inspection must include overall verification of physical condition.
- C. Moveable parts shall be adjusted, if needed, every 5 years.
- D. In areas of extreme winter conditions, entire installation must be free of excessive ice and snow accumulation.

3.18 DEMONSTRATION (For gate operator only.)

- A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain gates.
 - 1. Test and adjust [operators,] [controls,] [alarms,] [safety devices,] hardware, and other operable components. Replace damaged or malfunctioning operable components.
 - 2. Train Owner's personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
 - 3. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout." and/ or Section "Operation and Maintenance Data."
 - 4. Schedule training with Owner (, through Architect,) with at least seven days' advance notice. END OF SECTION 02821

END OF SECTION 32 31 19

SECTION 32 84 00 – 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

- B. Section includes The following irrigation system when fully completed shall water all noted turf and landscaped areas. It is the intent of the diagrammatic irrigation plan to install all products within the Owner’s property limits and within landscaped areas.
- C. Provide all labor, materials, equipment, and supervision required to construct the irrigation system including:
 - 1. Connection to the water supply
 - 2. Valves, mechanical and electrical;
 - 3. Controller, rain switch with bypass, Turf Guard moisture sensor and all wiring;
 - 4. Sleeving, piping; and
 - 5. Automatic sprinklers and sub-surface drip system.
- D. Related Requirements:
 - 1. Section 32 91 13 “Soil Preparation.”
 - 2. Section 32 92 00 “Turf and Grasses.”
 - 3. Section 32 93 00 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.
 - 4. Section 33 46 00 "Subdrainage" for below-grade drainage of landscaped areas.
 - 5. The Irrigation Contractor shall coordinate with the Landscape Contractors to ensure adequate and timely irrigation of all turf (seeded and sod) and plant materials and to establish the correct location of irrigation components relative to grassed and plant material beds.

1.3 DESCRIPTION OF WORK

- E. The following irrigation system when fully completed shall water all noted turf and landscaped areas. It is the intent of the diagrammatic irrigation plan to install all products within the Owner’s property limits and within landscaped areas.
- F. Provide all labor, materials, equipment, and supervision required to construct the irrigation system including:

1. Connection to the water supply
 2. Valves, mechanical and electrical;
 3. Controller, rain switch with bypass, Turf Guard moisture sensor and all wiring;
 4. Sleeving, piping; and
 5. Automatic sprinklers and sub-surface drip system.

- G. Irrigation system shall be installed as a complete coordinated system. All equipment whether mentioned or not shall be provided for the proper operation of irrigation system. Operation shall be as per manufacture recommendations and to the satisfaction of the Owner's Representative. It may be produced by manufacturer's as specified. All system components shall be coordinated to provide a fully compatible functioning system.

- H. It is the responsibility of the Irrigation Contractor to design and install a system in accordance with all LEED Requirements.

- I. Provide and install as required, the following – see plans:
 1. All new planting areas
 2. Adequate reserves to irrigate existing planters on property not currently in scope.

- J. Stub-out to lawn area @ 18" below both finish exterior grades and install a male pipe thread connection at turf end. Size as required. Coordinate with General Contractor.

- K. Provide and install 120V electrical power cable and outlet for irrigation controller on separate circuit. Coordinate location with owner.

- L. Provide and install the following:
 1. Connection to point of connection from water supply.
 2. Installation of irrigation controller(s) and connection to 120V circuit.

- M. Provide and install sleeves under walks and drives. Both piping and 24 VAC wiring sleeves shall be Schedule 40 PVC or C900 PVC. Size, depth, and location as required. Coordinate with General Contractor.

1.4 PRE-INSTALLATION MEETINGS

- N. Pre-installation Meeting: Conduct meeting at Project Site, Manufacturer's Facility of Fabricator's Shop. Confirm with Owner and Landscape Architect 14 days prior to conference.
 1. Before submitting submittals, review submittals, mockup and other requirements of this section and examine procedures for ensuring quality of the scope herein. Require representatives of each entity directly concerned with the scope herein, including but not limited to, the following:
 - a. Contractor's superintendent.
 - b. Subcontractor.
 - c. Special Subcontractor.
 - d. Product manufacturer and/or local representative.
 - e. Landscape Architect.

2. Review methods and procedures related to the work of this section, including but not limited to, the following:
 - a. Responsibilities of each party.
 - b. Coordination of Landscape Architect's review of the work, including but not limited to:
 - 1) Site or Shop Visits to Review Samples and Mockups
 - 2) Site Visits to Observe General Construction Progress
 - 3) Site or Shop Visits to Review Fabrication Progress
 - 4) Site Visits to Review First Work In Place
 - 5) Site Visits for Punch List Review
 - 6) Site Visits for Punch List Completion Review
 - 7) Site Visit for Warranty Review
 - c. Lines of authority and communication for the project. Procedures for resolution of any project document ambiguity.
 - d. Methods for documenting, reporting, and distributing documents and reports.
 - e. Proposed sources of materials.
 - f. Procedures for packaging and storing archive samples.
 - g. Review of the time schedule for all installation and testing. Schedule of workdays and/or starting times if third party testing verification is required.
 - h. Quality control.
 - i. Temperature and weather limitations. Installation procedures for adverse weather conditions. Defining acceptable subgrade or ambient moisture and temperature conditions for working during installation.
 - j. Subgrade conditions, dewatering responsibilities, and subgrade maintenance plan.
 - k. Deployment techniques including allowable subgrade conditions.
 - l. Construction, material placement, and backfilling.
 - m. Requirements for protecting work, including restriction of traffic and adjacent work impacting during installation period and for remainder of construction period.
 - n. Measurement and payment schedules.
 - o. Health and safety.
 - p. Procedures and responsibilities for preparation and submission of as-built drawings.

1.5 COORDINATION

- O. Refer to Division 1 Requirements.

1.6 ACTION SUBMITTALS

- P. Product Data: For each type of product.
 1. Manufacturer's Product Literature and Specification Data.
 2. Manufacturer's written instructions for recommended maintenance practices.
 3. Color and finish samples for verification and selection.
 4. Written manufacturer's warranty.
 5. Product liability insurance certificate with project owner as certificate holder.
 6. MSDS for items in Part 2 "Products."

- Q. Shop Drawings: Prepared by or under the supervision of a qualified professional, detailing fabrication and assembly.
 - 1. Submit shop drawings within a reasonable time so as not to delay the start of material fabrication and installation.
 - 2. Submit shop drawings per above allowing a minimum review time of 10 business days for review and response. Per above, also allow enough time for revisions and resubmittal where reasonably predictable.
 - 3. Shop drawings shall show the proposed layout identifying all components and details based on field verified conditions and measurements.

- R. Submit manufacturer's technical data and specifications for all component parts of the underground sprinkler system.

- S. Submit design and installation drawings (shop drawings) for underground irrigation system including plan layout and details illustrating location and type of heads, valves, piping circuits, controls, and accessories if modified from plan.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, Fabricator, Manufacturer and Testing agency.
- B. Material Certificates: For each of the following, signed by manufacturers:
 - 1. For all materials.
- C. Material Test Reports: For the following, from a qualified testing agency:
 - 1. For all materials.
- D. Preconstruction test reports.
- E. Source quality-control test reports.
 - A. Field quality-control and special inspection reports.
 - B. Minutes of pre-installation conference.
 - C. Maintenance Instructions.
 - D. Warranty: Written manufacturer's warranty.

1.8 CLOSEOUT SUBMITTALS

- A. Maintenance Data.

1.9 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Authorities Having Jurisdiction for all work included in this section.
- B. Codes and Standards: Conform work to all applicable codes and standards.
- C. Manufacturer Qualifications: Provide manufacturer qualifications as follows:
 - 1. Submit a list of ten completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.
 - 2. Submit qualifications of manufacturer.
 - 3. Submit manufacturer's quality control program.
 - 4. Submit example of Material Warranty and any other applicable warranties.
- D. Installer Qualifications: Provide installer qualifications as follows:
 - 1. Submit a list of ten completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.
 - 2. Submit resumes and/or qualifications of installation manager(s).
 - 3. Submit fabrication quality control program.
 - 4. Submit installation quality control program.
 - 5. Submit example of Material Warranty and any other applicable warranties.
- E. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified for testing indicated. Provide testing agency qualification as follows:
 - 1. Submit a list of ten completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.
 - 2. Submit resumes and/or qualifications of testing manager(s).
 - 3. Submit testing quality control program.
 - 4. Submit example of Material Warranty and any other applicable warranties.

1.10 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform all required preconstruction testing.

1.11 DELIVERY, STORAGE AND HANDLING

- A. Deliver packaged products in an undamaged condition in original containers, displaying manufacturer's labels, along with instructions for handling, storing, unpacking, protecting, and installing.

- B. Deliver and store materials in manufacturer's original containers, with seals unbroken and identification labels intact until time of use.
- C. Deliver products to achieve the shortest duration of storage time as practicable.
- D. Deliver all chemical products in original, unopened containers with original labels intact and legible, which state the guaranteed chemical analysis. Store all chemicals in weather protected enclosure.
- E. Comply with manufacturer's written instructions for delivery, storage, and handling, and as required to prevent damage to products and work during construction.
- F. Store products and materials in a neat and orderly manner. Maintain clear aisles and access to work areas. Protect stored products from theft and damage. Store products above ground in weathertight, ventilated packaging or enclosures.
- G. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.
- H. Store liquids in tightly closed containers protected from freezing.
- I. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- J. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk materials with appropriate certificates.

1.12 FIELD CONDITIONS

- T. Field Measurements: Verify actual locations of all site elements and other construction contiguous with the work of this section prior to fabrication and/or installation.
- U. The work shall not occur in the presence of standing water, mud, snow, or frozen subgrade conditions. Work shall not occur while precipitation is occurring or during excessive winds, or when temperatures are outside the limits specified in this specification. Work completed during these conditions will be rejected.
- V. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

- W. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
- X. Hot-Weather Requirements: Comply with hot-weather construction requirements.
- Y. Take precautions to ensure that equipment and vehicles do not disturb or damage existing site grading, walks, curbs, pavements, utilities, plants, and other existing items and elements on public and private property.
- Z. Verify locations and depths of all underground utilities prior to commencing excavation.
- AA. Repair and/or return to original condition any damage caused by Contractor's negligence at no cost to the Owner.
- BB. Existing Utilities:
 - 1. Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of support and protection during this work.
 - 2. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in full operation. Repair damaged utilities to satisfaction of utility owner.
 - 3. Do not interrupt existing utilities serving facilities occupied and used by Owner or others during occupied hours, except when permitted in writing by Owner and then only after acceptable temporary utility services have been provided.
 - 4. Provide minimum of 48-hour notice to Owner and Owner's Representative and receive written notice to proceed before interrupting any utility.
 - 5. Demolish and complete remove from site existing underground utilities indicated to be removed after complete deactivation. Coordinate with utility companies for shut-off of services if lines are active.
- CC. Protection of Persons and Property:
 - 1. Barricade open excavations occurring as part of this work and post warning lights.
 - 2. Operate warning lights as recommended by authorities having jurisdiction.
 - 3. Protect structures, utilities, sidewalks, pavements, curbs, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by this work.

1.13 EXCAVATING AND GRADING AROUND UTILITIES

- A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.
- B. Determine location of underground utilities and perform work in a manner that will avoid damage. Hand excavate as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.

- C. Notification of the utility locate services is required for all Excavation and grading deeper than 12 inches: The Contractor is responsible for knowing the location and avoiding utilities that are not covered by the local utility locator service.

1.14 OBSERVATION OF THE WORK

- A. The Landscape Architect may observe the work at any time. They may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting specifications shall be paid by the Contractor.
- B. The Landscape Architect shall be informed of the progress of the work so the work may be observed during key times in the construction process. The Landscape Architect shall be afforded sufficient time to schedule visits to the site. Failure of the Landscape Architect to make field observations shall not relieve the Contractor from meeting all the requirements of this specification.

1.15 FIRST WORK IN PLACE

- A. The Landscape Architect shall be informed once the first work in place has been completed for all individual elements included in this section for review to ensure the work is proceeding in accordance with the approved samples and mockups and per the Contract Documents. The Landscape Architect shall be afforded sufficient time to schedule visits to the site for review. In the event that sufficient time cannot be provided the Contractor shall provide images from multiple angles and perspectives of the work for Landscape Architect review.

1.16 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering and wear.
 - b. Separation or delamination of materials and components.
 - 2. Warranty Period: One year from date of Substantial Completion.

1.17 MAINTENANCE SERVICE

- DD. Contractor to provide standard industry maintenance on all scope items herein until Final Acceptance.

PART 2 - PRODUCTS

1.18 GENERAL

- A. All sprinklers, sub-surface irrigation, electric valves and controllers shall be as specified herein and on plan. Said equipment and other products are called out on the Irrigation Plans and or listed in the specifications below.
- B. All sprinkler equipment must be purchased by the local authorized serviced regional distributor.
- C. All components shall be for non-potable use (ie: sprinklers through piping) with purple markings and covers.

1.19 COPPER/D.I. PIPING – as per code (see mechanical plans)

- D. Copper/D.I. Piping. -As per local codes; provided by Irrigation Contractor and performed by licensed trade.

1.20 P.V.C. - PIPE

- E. Sizes 1” diameter and larger.
- F. Virgin, high impact, poly-vinyl chloride (P.V.C.) white pipe, Schedule 1120-1220. Mainline piping: class 200, having a minimum of 200 psi working pressure rating. Lateral piping: class 200, having a minimum of 200 psi working pressure rating.
- G. Continuously and permanently marked with manufacturer’s name, material, size, and schedule or type.
- H. Pipe: Conform to CS 207-60 or latest revision.
- I. Material: Conform to CS 256-63 or latest revision.

1.21 P.V.C. PIPE FITTINGS

- J. Sch. 40 P.V.C. solvent weld or belled fittings; saddles prohibited.
- K. Conform to ASTM D1784, ASTM D2466 or latest revision.

1.22 POLYETHYLENE PIPE - 1” Only

- L. Flexible polyethylene pipe rated at 100-psi minimum working pressure.

- M. 1" in diameter.
- N. Product Standard PS11-69 or ASTM D2239-73 for PE 2306, SDR-15 or latest revision.

1.23 POLYETHYLENE FITTINGS

- O. Schedule 100 P.V.C.
- P. All fittings larger than 1" shall be secured with double stainless steel clamps.

1.24 SADDLE TEES

- Q. Blazing Saddle self-tapping fitting as manufactured by Blazing Products Inc., St. Louis, MO, or approved equal.-1" only

1.25 SPRINKLER RISER OFF POLYETHYLENE PIPE or SWING PIPE

- R. Cut-off polyethylene risers mounted on saddle tees.
- S. Riser height as required.
- T. Swing pipe - as per manufacturer's recommendation - no longer than three (3) feet.

1.26 ELECTRICAL CONTROL VALVES

- U. Manufacturer's standard, of type as follows:-see plan
 - 1. Globe valves operated by low-power solenoid, normally closed, manual flow adjustment.

1.27 CONTROL CABLE

- V. All electrical control and ground wire shall be "UF/PE" direct burial.
- W. 12 ga. "UF/PE" white common neutral 14 ga. "PE" red control wire.
- X. A separate common neutral wire is required from controller along entire main line and dropped in marked valve box.
- Y. Provide one spare control wire from controller along entire main line.
- Z. No aluminum wire allowed.
- AA. Wiring used for connecting automatic remote control valve to automatic controllers shall be type "UF/PE", 600 volt, solid copper, single conductor wire with direct burial insulation and bear "UL" approval for direct underground burial feeder cable.

BB. Direct Bury Splice Kit: 3M DBY.

1.28 SUB-SURFACE DRIP TUBING

CC. Description

1. Sub-surface low volume dripperline with integral and evenly spaced pressure compensating, check valve drippers welded to the inside of the tubing at specified intervals. Drippers specified in four discharge rates (0.26, 0.4, 0.6 and 0.9 gallons per hour (GPH)) evenly spaced at 12", 18" or 24" centers. Blank tubing is available in 100', 250' and 1000' coils for non drip areas.

DD. Construction

1. Sub-surface tubing shall consist of 17mm, nominal sized one-half inch (1/2") low-density linear polyethylene tubing with pressure compensating, continuously self-cleaning, integral drippers with internal check valve at a specified spacing, (12", 18" or 24" centers) or blank tubing without drippers. The tubing shall be brown in color and conform to an outside diameter (O.D.) of 0.66 inches and an inside diameter (I.D.) of 0.56 inches. Individual pressure compensating drippers shall be welded to the inside wall of the tubing as an integral part of the tubing assembly. These drippers shall be constructed of a 2-piece plastic dripper housing containing a continuously self-flushing silicone diaphragm capable of flushing any dirt or debris that may enter the dripper, extending the full length of the dripper. The dripper shall have a built-in check valve that will hold the pressure exerted by a 4 1/2' column of water (2psi) to ensure it draws water from the center of the water stream thereby ensuring the dripper is always drawing water from the cleanest part of the stream of water flowing through the tubing. The dripper shall also have a built-in physical root barrier whereby the water shall exit the dripper from one location and shall exit the tubing from a second location. This physical barrier shall create an air gap inside the tubing.

EE. Operation

1. Each dripper shall have the ability to independently regulate discharge rates, with an inlet pressure of fourteen point seven to seventy (14.7 – 70) pounds per square inch (psi), at a constant flow and with a manufacturer's coefficient of variability (Cv) of 0.03 or less. Recommended operating pressure shall be between 20-50 psi. The dripper discharge rate shall be 0.26, 0.4, 0.6 or 0.9 gallons per hour (GPH) utilizing a combination turbulent flow/reduced pressure compensation cell mechanism and a diaphragm. The drippers shall be capable of continuously cleaning themselves while in operation. The dripperline shall be available with 12", 18" and 24" spacing between drippers unless otherwise specified. For sub-surface installation, tubing pipe depth shall be minimal depth specified in plans to 6" maximum unless otherwise specified. Maximum system pressure shall be 50 psi. Filtration shall be 120 mesh or finer. Bending radius shall be 7". For on-surface or under mulch installations, 6" metal wire staples (TLS6) shall be installed 3'-5' on center, (depending on soil type) and two staples shall be installed over every change-of-direction fitting.

1.29 SPRINKLER HEADS – See plan and details for specified equipment

FF. Sprinkler heads: Manufacturer’s standard unit designed to provide uniform coverage over entire designated area at available or boosted water pressure. Types as follows:

1. High efficient Pop-Up Spray: Fixed pattern, with screw-type flow adjustment and stainless steel retraction spring.
2. Sub-surface irrigation: Self cleaning external emitted drip piping with disk filters and PRV.

GG. Spacing of tubing and heads shall not exceed manufacturer’s maximum recommendations. Head-to-head coverage is required for spray and rotary type sprinklers.

HH. Matched precipitation will be required on all sprinklers operating on the same zone.

II. Conform to manufacturer’s specifications concerning diameter of throw and gallonage at given pressures.

1.30 CONTROL EQUIPMENT – See Plan

JJ. Furnish low voltage system manufactured expressly for control of automatic circuit valves of underground irrigation systems. Provide unit(s) of capacity to suit number of circuits.

KK. Exterior Control Enclosure: Manufacturer’s standard with locking cover, complying with NFPA 70.

LL. Transformer: To convert building service voltage to control voltage of 24 volts.

MM. Circuit Control: Each circuit variable from approximately 5 to 60 minutes. Include switch for manual or automatic operation of each circuit.

NN. Timing Device: Adjustable, 24-hour and 7 or 14 day clocks to operate any time of day and skip any day in a 7 or 14 day period.

OO. Settings: solid state.

PP. Coordinate location of controller(s) with Landscape Architect and/or Owner.

QQ. No time lag between sections or stations.

1.31 REDUCED PRESSURE BACKFLOW DEVICE – as per codes

RR. Manufacturer’s standard, to suit sprinkler system

1.32 METER – as per codes

SS. Irrigation Contractor to work with Mechanical Contractor for the installation of said water meters.

TT. Meter Location to be reviewed with Landscape Architect prior to installation.

1.33 QUICK COUPLING VALVES

UU. Located in intervals along all mainline pipe with swing joints and stabilizers. Verify final locations with Landscape Architect.

VV. Install quick coupling valve in Ametek's standard circular valve box.

WW. Provide matching quick coupler keys. One key for each 3 coupling valves. Keys to be given to Owner appointed maintenance personnel with close-out instructions and manuals.

1.34 ISOLATION VALVES

XX. Actual location to be reviewed with Landscape Architect and/or Owner Valves and boxes not to impede with root balls or protection zones.

YY. Size valve to match line size.

ZZ. Install isolation valves in 12" standard valve box according to the plans.

1.35 VALVE BOX FOR ELECTRICAL CONTROL VALVES, QUICK COUPLING VALVES, AND ISOLATION VALVES – See Detail & Plan

AAA. Single Valve Setup: Ametek 12" standard box.

BBB. Multi-Valve Setup: Ametek's jumbo box. Use manufacturer's recommended extension kits if required.

CCC. Quick Coupling Valves: Ametek's 10" circular box.

1.36 SLEEVES

DDD. Coordinate with General Contractor.

1.37 THRUST BLOCK

EEE. Pour concrete thrust blocks at all change of directions to ensure against pipe separation.

FFF. Coordinate with General Contractor

1.38 SWING JOINTS – QCV w/STABILIZER

GGG. LASCO 360 deg. Swing Joint Assembly as manufactured by Philips Industries or approved substitute.

PART 3 - EXECUTION

1.39 INSPECTION

- A. Prior to installation examine site to confirm that existing conditions are satisfactory for the work of this section to proceed.
- B. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope toward the under drain lines as shown on the drawings.
- C. Confirm that no adverse drainage conditions are present.
- D. Confirm that no conditions are present which are detrimental to plant growth.
- E. Confirm that utility work has been completed per the drawings.
- F. If unsatisfactory conditions are encountered, notify the Landscape Architect immediately to determine corrective action prior to proceeding.

1.40 PREPARATION

- G. N/A.

1.41 COORDINATION WITH PROJECT WORK

- H. The Contractor is responsible for investigating, and being aware of, the work requirements of their sub-contractors and other contractors. The Contractor shall coordinate with all other work that may impact the completion of the work herein.
- I. Prior to the start of work, prepare a detailed schedule of the work for coordination with other trades.

1.42 SYSTEM DESIGN

- J. Design Pressure: Verify static water pressure with Mechanical Plans. Contractor to work with mechanical contractor to confirm a minimum of 65 psi city static.
- K. Location of Heads and Sub-surface Irrigation: Locate heads and tubing as per manufacturer's recommendations. Make minor adjustments as necessary to avoid plantings and other obstructions and to provide proper location relative to finished lawns and plant beds, at no additional cost to the Owner. Irrigation system layout is diagrammatic. Exact locations of piping, sprinkler heads, valves, and other components shall be established by the Contractor in the field at time of installation and on the approved shop drawings. Landscape Architect to approve such locations.
- L. Minimum Water Coverage: Design to deliver the equivalent of 1.5" of rainfall per week. System total operating time not to exceed 12 hours per 24-hour day.

- M. Minor adjustments to system field layout will be permitted to clear existing fixed obstructions; final field layout shall be acceptable to the Owner and Landscape Architect based on the approved shop drawings.

1.43 TIMING

- N. Coordinate time schedule with Owner's representative. Landscape Contractor to evaluate and adjust to insure plants have best care at end of warranty. Over or under watering shall be grounds of plant rejection.

1.44 INSTALLATION

- O. Excavating and backfilling:

1. Excavation shall include all materials encountered, except materials that cannot be excavated by normal mechanical means.
2. Excavate trenches of sufficient depth and width to permit proper handling and installation of pipe and fittings.
3. If the pulling method is used, the pipe "plow" shall be a vibratory type. Starting and finishing holes for pipe pulling shall not exceed a 1'-0" by 3'-0" opening.
4. Excavate to depths required to provide 2" depth of earth fill or sand bedding for piping when rock or other unsuitable bearing material is encountered.
5. Fill to match adjacent grade elevations with approved earth fill material. Place and compact fill in layers not greater than 8" depth.
 - a. Provide approved earth fill or sand to a point 4" above the top of pipe.
 - b. Overfill with approved excavated or borrow fill materials free of lumps or rocks larger than 3" in any dimension. Level, compact and water settle. Should settlement occur, refill and re-sod as required.
6. Except as indicated, install irrigation mains with a minimum cover of 18" based on finished grades. Install irrigation laterals with a minimum cover of 12" based on finished grades.
7. Excavate trenches and install piping and fill during the same working day. Do not leave open trenches or partially filled trenches open overnight.

- P. Plastic Pipe:

1. Install plastic pipe in accordance with manufacturer's installation instructions. Provide for thermal expansion and contraction.
2. Saw cut plastic pipe. Use a square-in-sawing vice to ensure a square cut. Remove burrs and shavings at cut ends prior to installation.
3. Make plastic to plastic joints with solvent welded joints or slip seal joints. Use only solvent recommended by the pipe manufacturer. Install plastic pipe fittings in accordance with pipe manufacturer's instructions. Contractor shall make arrangements with pipe manufacturer for all necessary field assistance.
4. Make plastic to metal joints with toe nipples, no male adaptors.
5. Make solvent weld joints in accordance with manufacturer's recommendations.
6. Allow joints to set at least 24 hours before pulling or pressure is applied to the system.
7. Uncoil poly-pipe and insert fitting full depth. Secure poly-pipe to insert fittings with stainless steel clamps. Double clamp pipe over 1" diameter.
8. Maintain pipe interiors free of dirt and debris. Close open ends of pipe by acceptable methods when pipe installation is not in progress and over all non-working hours.

Q. Sprinklers, sub-surface, fittings, valves, and accessories:

1. Install fittings, valves, sprinkler heads, risers, sub-surface and accessories in accordance with manufacturer's instructions, except as otherwise indicated.
 - a. Provide concrete thrust blocks where required at fittings valves and all change of directions.
2. Set sprinkler heads perpendicular to finish grades, except as otherwise indicated and approved by Landscape Architect.
3. Install pop-up spray heads with polyethylene "cut-off" risers or swing pipe
4. Obtain Owner's Representative's and Landscape Architects review and acceptance of height for proposed sprinkler heads and valves prior to installation.
5. Locate sprinkler heads to assure proper coverage of indicated areas. Do not exceed sprinkler head spacing distances indicated.
6. Install gear-driven sprinklers on 360-degree swing joint assembly as per manufacturer's recommendation.
7. Install quick-coupling valves in 10" valve box on 360-degree swing joint assembly as per manufacturer's recommendation with stabilizer.
8. Install fittings and accessories as shown or required to complete the system.
9. Install controller as detailed:
 - a. Coordinate location with Owner and Landscape Architect.
 - b. Waterproof wire conduit to provide a complete, waterproof, permanent and neat job.
 - c. Ground controller in accordance with manufacturer's recommendations.
10. Install in-ground control valves in a valve access box.
11. Install valve access boxes on a suitable base of gravel to provide a level foundation at proper grade to provide drainage of the access box.
12. Seal threaded connections on pressure side of control valves as per manufacturer's recommendations.

R. Control wiring:

1. Install electric control cable in the piping trenches wherever possible. Place wire in trench adjacent to pipe. Install wire with slack to allow for thermal expansion

and contraction. Expansion joints in wire shall be provided at 200-foot intervals by making 5-6 turns of the wire around a piece of 1/2" pipe instead of slack. Where necessary to run wire in a separate trench, provide a minimum cover of 12".

2. Provide sufficient slack at site connections at remote control valves in control boxes, and at all wire splices to allow raising the valve bonnet or splice to the surface without disconnecting the wires when repair is required.
3. Connect each remote control valve to one station of a controller except as otherwise indicated.
4. Connect remote control valves to a common ground wire system independent of all other controllers. A separate common neutral wire is required for each controller.
5. Make wire connections to remote control electric valves and splices of wire in the field, using 3M DBY or 3M DBR Direct Bury Splice Kit (or approved equal).
6. Provide tight joints to prevent leakage or water and corrosion build-up on the joint.

S. Interior plumbing: Coordinate with Mechanical Contractor

1. Install piping to provide complete drainage of the system, toward the source wherever possible. Provide drain valves at all drainage points on pipes. Cut a pipe accurately to measurements established at the building and installed without springing or forcing. After cutting and reaming, and before assembling, remove interior scale, dust, and foreign matter. Installed pipe shall follow building lines, clearing all doors and other openings. No diagonal piping will be accepted. Install piping to allow installation of 1" thickness pipe installation covering. Provide for thermal expansion and contraction of pipe - as required.
2. Insulate piping with 1" thickness of fibrous glass insulation, 35 degree service, with white kraft paper jacket and .001" aluminum foil vapor barrier - as required.
3. All plumbing shall conform to all local codes and regulations.

T. Sleeves: Coordinate timing of installation with General Contractor

U. Flushing, testing, and adjustment:

1. After sprinkler piping and risers/swing joints are installed and before sprinkler heads are installed, open control valves and flush out the system with full head of water.

2. Perform system testing upon completion of each section. Make necessary repairs and re-test repaired sections as required.
3. Adjust sprinklers after installation for proper and adequate distribution of the water over the coverage pattern. Adjust for the proper arc of coverage.
4. Tighten nozzles on spray type sprinklers after installation. Adjust sprinkler adjusting screw on lateral line or circuit as required for proper radius. Interchange nozzles patterns as directed by the Owner's representative to give best arc of coverage.
5. Adjust all electric remote control valve flow control stems for system balance.
6. Test and demonstrate the controller by operating appropriate day, hour, and station selection features as required to automatically start and shut down irrigation cycles to accommodate plant requirements and weather conditions.

1.45 AS-BUILT DRAWING

- V. Furnish accurate reproducible "As-Built" drawings of all components. State the size, manufacturer, model number, part number, and exact location of each and every item furnished and installed by this Contractor. Final payment can be withheld until "as-built" has been provided to the Owner and approved by Owner or Owner's Representative.
- W. Provide all manufactures specifications, operating and maintenance directions for all products within the system.
- X. Contractor will furnish Owner with 2 bound copies of instruction sheets and parts lists covering all operating equipment.

1.46 DISPOSAL OF WASTE MATERIAL

- Y. Stockpile, haul from site, and legally dispose of waste materials, including unsuitable excavated materials, rock, trash, and debris.
- Z. Maintain disposal route clear, clean and free of debris.
- AA. Repair any damage resulting from irrigation system installation.
- BB. All disposals to be in accordance with LEED Requirements.

1.47 ACCEPTANCE

- CC. Prior to final inspection and irrigation system acceptance written operating and maintenance instructions and obtain Landscape Architect's or Irrigation Consultant's approval for same in writing. Provide Owner's appointed maintenance personnel instruction and demonstration in the proper operation, programming and monitoring of irrigation system, as well as provide a four-hour period set aside for training of irrigation with Owner's staff in the complete operation and regular maintenance. Test and demonstrate to the Owner the satisfactory operation of the system free of leaks.

DD. Instruct the Owner in the operation of the system, including adjustment of sprinklers, controller(s), valves, and pump controls.

EE. Upon acceptance, the Owner will assume operation of the system.

1.48 GRADE AND ELEVATION CONTROL

FF. Provide grade and elevation control during installation of the work of this section. Utilize grade stakes, surveying equipment, and other means and methods to assure that grades and contours conform to the grades indicated on the plans.

1.49 REPAIR AND REPLACEMENT

GG. General: Repair or replace that is damaged by construction operations, in a manner approved by Landscape Architect.

1.50 WASTE HANDLING

HH. General: Handle waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

1.51 CLEANING

II. The contractor should clean the job site and remove any excess materials. Coordinate with Owner for storage locations for any Attic Stock materials where applicable.

1.52 PROTECTION

JJ. Contractor shall furnish and install construction fence around new installations to prevent access. Fencing shall be maintained in place for a minimum of 48 hours after completion of installation, or as directed by the Landscape Architect. Drying period may take longer due to weather conditions.

KK. Contractor shall notify Landscape Architect that landscape irrigation shall be restricted near installations until applicable drying period is complete. Standing water on installations shall be restricted at all times.

1.53 MAINTENANCE SERVICE

LL. Maintenance Service: Provide maintenance by skilled employees of Installer or approved Subcontractor. Maintain as required in "Maintenance" Article. Begin maintenance immediately after scope is installed and continue until final acceptance.

1.54 DEMONSTRATION AND TRAINING

- MM. Engage a manufacturer-authorized service representative and/or other authorized professional to train Owner's maintenance personnel to adjust and operate all components herein.
- NN. Train Owner's maintenance personnel in proper maintenance procedures for all components herein.

1.55 SPECIAL INSTRUCTIONS

- OO. The Contractor shall coordinate and cooperate with the General Contractor, Mechanical/Electrical Contractors, and all subcontractors, during the installation of this system.
- PP. During the bidding period, the Irrigation Contractor shall inform the Bidding General Contractors of any system items or elements that are required for operation of the system specified herein, that are not being furnished and installed by the Irrigation Contractor.
- QQ. The lawn irrigation system must be in full operation by the time the new sod/seed and landscape are in place. It is the intent and mandatory requirement that the sprinklers be installed before the plant material and provide the water for the newly placed landscape.
- RR. It is the intent of the Owner to use moderate to heavy motorized lawn mowers to maintain the turf on this project. All sprinkler heads shall safely sustain these loads without failure.
- SS. Contractor shall be responsible for drainage and winterizing the system for the first year of operation.
- TT. Contractor shall be responsible for start-up the following year/spring.
- UU. Contractor to schedule winterizing and start-up with Owners approved maintenance rep. Owner's Representative to be present for winterization and start-up instructions.
- VV. Contractor shall provide to the Owner (5) irrigation heads, of each type, at time of final close-out
- WW. Contractor shall provide to the Owner (2) quick connections at time of final close-out

END OF SECTION - 32 84 00

SECTION 32 91 13 – 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 layered soil assemblies specified by composition of the mixes. Section also includes all labor, materials, tools, supplies, equipment, facilities, transportation and services necessary for, and incidental to performing all operations in connection with furnishing, delivery, and installation of Planting Soil and /or the modification of existing site soil for use as Planting Soil, complete as shown on the drawings and as specified herein.
- B. The scope of work in this section includes, but is not limited to, the following:
 - 1. Locate, purchase, deliver and install Imported Planting Soil and soil amendments.
 - 2. Harvest and stockpile existing site soils suitable for Planting Soil.
 - 3. Modify existing site soil in place for use as Planting Soil.
 - 4. Locate, purchase, deliver and install subsurface Drain Lines.
 - 5. Fine grade Planting Soil.
 - 6. Install Compost into Planting Soils.
 - 7. Clean up and disposal of all excess and surplus material.
- C. Related Requirements:
 - 1. Section 12 93 00 "Site Furnishings" for placing planting soil in exterior unit planters.
 - 2. Section 32 92 00 "Turf and Grasses."
 - 3. Section 32 93 00 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.
 - 4. Section 33 46 00 "Subdrainage" for below-grade drainage of landscaped areas.

1.3 REFERENCES

- A. The following specifications and standards of the organizations and documents listed in this paragraph form a part of the Specification to the extent required by the references thereto. In the event that the requirements of the following referenced standards and specification conflict with this specification section the requirements of this specification shall prevail. In the event that the requirements of any of the following referenced standards and specifications conflict with each other the more stringent requirement shall prevail.

1. ASTM: American Society of Testing Materials cited section numbers.
2. U.S. Department of Agriculture, Natural Resources Conservation Service, 2003. National Soil Survey Handbook, title 430-VI. Available Online.
3. US Composting Council www.compostingcouncil.org
4. *Methods of Soil Analysis*, as published by the Soil Science Society of America (<http://www.soils.org/>).
5. *Up by Roots: healthy soils and trees in the built environment*. 2008. J. Urban. International Society of Arboriculture, Champaign, IL.

1.4 CONTRACT DOCUMENTS

- A. Shall consist of specifications and its general conditions and the drawings. The intent of these documents is to include all labor, materials, and services necessary for the proper execution of the work. The documents are to be considered as one. Whatever is called for by any parts shall be as binding as if called for in all parts.

1.5 VERIFICATION

- A. All scaled dimensions on the drawings are approximate. Before proceeding with any work, the Contractor shall carefully check and verify all dimensions and quantities, and shall immediately inform the Landscape Architect of any discrepancies between the information on the drawings and the actual conditions, refraining from doing any work in said areas until given approval to do so by the Landscape Architect.

1.6 PERMITS, FEES AND REGULATIONS

- A. Permits: The Contractor shall secure and pay for all permits, inspections, and certificates of inspection of any governmental and inspection body having jurisdiction over all or any part of the work included under this section and/or such inspections etc., required by these specifications.
- B. Fees: The Contractor shall secure and pay for all fees and assessments in connection with the work under this contract and shall include this cost in its bid and contract price.
- C. The Contractor shall comply with all laws and ordinances bearing on the operation or conduct of the work as drawn and specified. If the Contractor observes that a conflict exist between permit requirements and the work outlined in the contract documents, the Contractor shall promptly notify the Landscape Architect in writing including a description of any necessary changes and changes to the contract price resulting from changes in the work.
- D. Wherever references are made to standards or codes in accordance with which work is to be performed or tested, the edition or revision of the standards and codes current on the effective date of this contract shall apply, unless otherwise expressly set forth.
- E. In case of conflict among any referenced standards or codes or between any referenced standards and codes and the specifications, the more restrictive standard shall apply or Landscape Architect shall determine which shall govern.

1.7 PROTECTION OF WORK, PROPERTY AND PERSON

- A. The Contractor shall adequately protect the work, adjacent property, and the public, and shall be responsible for any damages or injury due to the Contractor's actions.

1.8 CORRECTION OF WORK

- A. The Contractor shall re-execute any work that fails to conform to the requirements of the contract and shall remedy defects due to faulty materials or workmanship upon written notice from the Landscape Architect, at the soonest possible time that can be coordinated with other work and seasonal weather demands, but not more than 180 (one hundred and eighty) days after notification.

1.9 DEFINITIONS

- A. Acceptable drainage: Drainage rate is sufficient for the plants to be grown and as further defined in this specification
- B. Amendment: material added to Topsoil to produce Planting Soil Mix or added to planting soil to modify the soil chemically, physically or organically.
- C. AAPFCO: Association of American Plant Food Control Officials.
- D. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.
- E. CEC: Cation exchange capacity.
- F. Compacted soil: soil where the density of the soil is greater than the threshold for root limiting.
- G. 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. as defined by the US Composting Council and further defined in this specification.
- H. Drainage: The rate at which soil water moves through the soil transitioning the soil from saturated condition to field capacity. Most often expressed as saturated hydraulic conductivity (Ksat; units are inches per hour).
- I. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.
- J. End of Warranty Acceptance: The date when the Landscape Architect accepts that the plants and work in this section meet all the requirements of the warranty. It is intended that the materials and workmanship warranty for Planting, Planting Soil, and Irrigation work run concurrent with each other and as further defined in this specification..

- K. Existing Soil: Mineral soil existing at the locations of proposed planting after the majority of the construction within and around the planting site is completed and just prior to the start of work to prepare the planting area for soil modification and/or planting, or soils defined as usable soil to be stripped and stockpiled for reuse at the site and as further defined in this specification.
- L. Fertilizer: amendment used for the purpose of adjusting soil nutrient composition and balance and further defined in this specification.
- M. Fine grading: The final grading of the soil to achieve exact contours and positive drainage, often accomplished by hand rakes or drag rakes other suitable devices, and further defined in this specification, and further defined in this specification.
- N. Finished grade: surface or elevation of Planting Soil after final grading and 12 months of settlement of the soil, and as further defined in this specification.
- O. Graded soil: Soil where the A horizon has been stripped and relocated or re-spread; cuts and fills deeper than 4 inches.
- P. Imported Soil: Soil that is transported to Project site for use.
- Q. Installed soil: Planting soil and existing site soil that is spread and or graded to form a planting soil, and as further defined in this specification.
- R. Landscape Architect: The person or entity, appointed by the Owner to represent their interest in the review and approval of the work and to serve as the contracting authority with the Contractor. The Landscape Architect may appoint other persons to review and approve any aspects of the work.
- S. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.
- T. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.
- U. 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.
- V. 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."
- W. Ped: a clump or clod of soil held together by a combination of clay, organic matter, and fungal hyphae, retaining the original structure of the harvested soil.
- X. Pine Bark Fines: Horticultural grade, finely ground, ½" screened, and aged Southern Yellow Pine bark fines with cambium and wood fiber removed and further defined in this specification

- Y. 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.
- Z. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.
- AA. Scarify: Loosening and roughening the surface of soil and sub soil prior to adding additional soil on top, and as further defined in this specification.
- BB. Soil Fracturing: Deep loosening the soil to the depths specified by using a back hoe, and as further defined in this specification.
- CC. Soil Horizons: As defined in the USDA National Soil Survey Handbook http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242
- DD. Soil Ripping: Loosening the soil by dragging a ripping shank or chisel thru the soil to the depths and spacing specified, and as further defined in this specification.
- EE. SSSA: Soil Science Society of America.
- FF. Soil Tilling: Loosening the surface of the soil to the depths specified with a rotary tine tilling machine, or rototiller and further defined in this specification.
- GG. Soils Consultant: Provides the required independent site analysis, soil sampling, soil testing, and recommendations for soil modification, and as further defined in this specification.
- HH. 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.
- II. 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.
- JJ. Substantial Completion Acceptance: The date at the end of the Planting, Planting Soil, and Irrigation installation where the Landscape Architect accepts that all work in these sections is complete and the Warranty period has begun. This date may be different than the date of substantial completion for the other sections of the project, and as further defined in this specification.
- KK. 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.
- LL. Topsoil: naturally produced and harvested soil from the A horizon or upper layers or the soil as further defined in this specification.
- MM. USCC: U.S. Composting Council.

1.10 PRE-INSTALLATION MEETINGS

- A. Pre-installation Meeting: Conduct meeting at Project Site, Manufacturer's Facility of Fabricator's Shop. Confirm with Owner and Landscape Architect 14 days prior to conference.
1. Before submitting submittals, review submittals, mockup and other requirements of this section and examine procedures for ensuring quality of the scope herein. Require representatives of each entity directly concerned with the scope herein, including but not limited to, the following:
 - a. Contractor's superintendent.
 - b. Subcontractor.
 - c. Special Subcontractor.
 - d. Independent testing agency responsible for testing.
 - e. Product manufacturer and/or local representative.
 - f. Authority Having Jurisdiction.
 - g. Landscape Architect.
 2. Review methods and procedures related to the work of this section, including but not limited to, the following:
 - a. Responsibilities of each party.
 - b. Coordination of Landscape Architect's review of the work, including but not limited to:
 - 1) Site or Shop Visits to Review Samples and Mockups
 - 2) Site Visits to Observe General Construction Progress
 - 3) Site or Shop Visits to Review Fabrication Progress
 - 4) Site Visits to Review First Work In Place
 - 5) Site Visits for Punch List Review
 - 6) Site Visits for Punch List Completion Review
 - 7) Site Visit for Warranty Review
 - c. Lines of authority and communication for the project. Procedures for resolution of any project document ambiguity.
 - d. Methods for documenting, reporting, and distributing documents and reports.
 - e. Proposed sources of materials.
 - f. Procedures for packaging and storing archive samples.
 - g. Review of the time schedule for all installation and testing. Schedule of workdays and/or starting times if third party testing verification is required.
 - h. Quality control.
 - i. Temperature and weather limitations. Installation procedures for adverse weather conditions. Defining acceptable subgrade or ambient moisture and temperature conditions for working during installation.
 - j. Subgrade conditions, dewatering responsibilities, and subgrade maintenance plan.
 - k. Deployment techniques including allowable subgrade conditions.
 - l. Construction, material placement, and backfilling.
 - m. Requirements for protecting work, including restriction of traffic and adjacent work impacting during installation period and for remainder of construction period.
 - n. Measurement and payment schedules.
 - o. Health and safety.

- p. Procedures and responsibilities for preparation and submission of as-built drawings.

1.11 COORDINATION

- A. Refer to Division 1 Requirements.
- B. The Contractor shall coordinate the work with all trades and appropriate sections of the construction specifications as necessary to ensure proper provisions for the work of this section.
- C. The Contractor shall be responsible for the protection of the Owner's property from injury or loss due to its work. All damage to existing property (building, utilities, pavement, etc.) or planting (trees, shrubs, lawn or ground cover) caused by the Contractor during its operation or as a result of malfunction of installed work during the guarantee period shall be repaired at the Contractor's expense.
- D. The Contractor shall fully inform itself regarding any available space limitations and unusual requirements, for the installation of all materials and work furnished under this section. Although the location of equipment may be shown on the drawings in certain positions, the Contractor shall confirm all locations.
- E. Contractor shall also be guided by the Landscape Architectural details and conditions at the job, correlating its work with that of the other sections and other trades, with discrepancies and interferences being brought to the attention of the Architect for resolution prior to proceeding with the work.

1.12 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Manufacturer's written instructions for recommended maintenance practices.
 - 2. Color and finish samples for verification and selection.
 - 3. Written manufacturer's warranty.
 - 4. Product liability insurance certificate with project owner as certificate holder.
 - 5. MSDS for items in Part 2 "Products."
 - 6. Include recommendations for application and use.
 - 7. Include test data substantiating that products comply with requirements.
 - 8. Include sieve analyses for aggregate materials.
 - 9. 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 SU1P #25.
 - c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.

- B. Soil testing for Imported and Existing Topsoil, existing site soil to be modified as Planting Soil and Planting Soil Mixes and associated ammendments.
1. Topsoil, existing site soil and Planting Soil Mix testing: Submit soil test analysis report for each sample of Topsoil, existing site soil and Planting Soil from an approved soil-testing laboratory and where indicated in Part 2 of the specification as follows:
 - a. Submit Planting Soil Mix test no more than 2 weeks after the approval of the Topsoil, Coarse Sand, Compost, Pine Fines, and Lightweight Aggregate. Do not submit to the testing laboratory, Planting Soil Mixes, for testing until all Topsoil, Coarse Sand, Compost, Pine Fines, and Lightweight Aggregate have been approved.
 - b. If tests fail to meet the specifications, obtain other sources of material, retest and resubmit until accepted by the Landscape Architect.
 - c. All soil testing will be at the expense of the Contractor.
 2. Provide a particle size analysis (% dry weight) and USDA soil texture analysis. Soil testing of Planting Soil Mixes shall also include USDA gradation (percentage) of gravel, coarse sand, medium sand, and fine sand in addition to silt and clay.
 3. Provide the following other soil properties:
 - a. pH and buffer pH.
 - b. Percent organic content by oven dried weight.
 - c. Nutrient levels by parts per million including: phosphorus, potassium magnesium, manganese, iron, zinc and calcium. Nutrient test shall include the testing laboratory recommendations for supplemental additions to the soil for optimum growth of the plantings specified.
 - d. Soluble salt by electrical conductivity of a 1:2 soil water sample measured in Milliohm per cm.
 - e. Cation Exchange Capacity (CEC).
 - f. Sodium (Na) levels by parts per million
 4. For each Compost product submit the following analysis by a recognized laboratory:
 - a. pH
 - b. Salt concentration (electrical conductivity)
 - c. Moisture content %, wet weight basis
 - d. Particle size % passing a selected mesh size, dry weight basis
 - e. Stability carbon dioxide evolution rate mg CO₂-C per g OM per day
 - f. Solvita maturity test
 - g. Physical contaminants (inerts) %, dry weight basis
 - h. US EPA Class A standard, 40CFR § 503.13, Tables 1 and 3 levels Chemical Contaminants mg/kg (ppm)
 5. For each Pine Bark Fines product submit the following analysis by a recognized laboratory:
 - a. pH
 - b. Salt concentration (electrical conductivity)
 - c. Moisture content %, wet weight basis
 - d. Particle size % passing a selected mesh size, dry weight basis
 - 1/2 inch (12.7mm)
 - 3/8 inch (9.5mm)

- 1/4 inch (6.35mm)
 - No 4 (4.75mm)
 - e. C:N
 - f. Bulk density
 - 6. For Lightweight Aggregate product submit the following analysis by a recognized laboratory:
 - a. Material type
 - b. Dry and saturated weights
 - c. pH
 - d. Co-efficient of Uniformity D60/D10 and Finess modulus
 - e. Particle size distribution (percent passing the following sieve sizes):
 - 1/2" (12.7mm)
 - 3/8" (9.51mm)
 - #4 (4.76mm)
 - #8 (2.38mm)
 - 7. For Coarse Sand product submit the following analysis by a recognized laboratory:
 - a. pH
 - b. Co-efficient of Uniformity D60/D10 and Finess modulus
 - c. Particle size distribution (percent passing the following sieve sizes):
 - 3/8 inch (9.5mm)
 - No 4 (4.75mm)
 - No 8 (2.36mm)
 - No 16 (1.18mm)
 - No 30 (0.60mm)
 - No 50 (0.30mm)
 - No 100 (0.15mm)
 - No 200 (0.075mm)
- C. Samples: For each bulk-supplied material, 1-quart (1-L) volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.
 - 1. Submit samples a minimum of 8 weeks prior to the anticipated date of the start of soil installation.
 - 2. Samples of all Topsoil, Coarse Sand, Compost, Pine Fines, Lightweight Aggregate, and Planting Soil shall be submitted at the same time as the particle size and physical analysis of that material.
- D. Samples for Verification: For each type of selection made above provide a final sample.

1.13 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, Fabricator, Manufacturer and Testing agency.
- B. Material Certificates: For each of the following, signed by manufacturers:

1. For all materials.
- C. Material Test Reports: For the following, from a qualified testing agency:
 1. For all materials.
- D. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.
- E. Source quality-control test reports.
- A. Field quality-control and special inspection reports.
- B. Minutes of pre-installation conference.
- C. Maintenance Instructions.
- D. Warranty: Written manufacturer's warranty.

1.14 CLOSEOUT SUBMITTALS

- A. Maintenance Data: From Installer including a recommended maintenance plan with procedures for inspection and care during a calendar year. Submit before start of required warranty and maintenance periods

1.15 MAINTENANCE MATERIAL SUBMITTALS

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

1.16 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Authorities Having Jurisdiction for all work included in this section.
- B. Codes and Standards: Conform work to all applicable codes and standards.
- C. Manufacturer Qualifications: Provide manufacturer qualifications as follows:
 1. Submit a list of ten completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.
 2. Submit qualifications of manufacturer.
 3. Submit manufacturer's quality control program.
 4. Submit example of Material Warranty and any other applicable warranties.

- D. **Installer Qualifications:** The installer shall be a firm having at least 5 years of successful experience of a scope similar to that required for the Work, including the preparation, mixing and installation of custom planting. The installer of the work in Section: Planting, shall be the same firm installing the work in this section.
1. The bidders list for work under this section shall be approved by the Landscape Architect.
 2. **Installer Field Supervision:** When any Planting Soil work is in progress, installer shall maintain, on site, an experienced full-time supervisor who can communicate in English with the Landscape Architect.
 3. Installer's field supervisor shall have a minimum of five years of experience as a field supervisor installing soil, and shall be trained and proficient in the use of field surveying equipment to establish grades.
 4. The installer's crew shall be experienced in the installation of Planting Soil, plantings, and irrigation (where applicable) and interpretation of planting plans, soil installation plans, and irrigation plans (where applicable).
 5. Submit references of past projects, employee training certifications that support that the Contractor meets all of the above installer qualifications and applicable licensures.
- E. **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. **Multiple Laboratories:** At Contractor's option, work may be divided among qualified testing laboratories specializing in physical testing, chemical testing, and fertility testing.
- F. All delivered and installed Planting Soil shall conform to the approved sample color, texture and approved test analysis.
1. The Landscape Architect may request samples of the delivered or installed soil be tested for analysis to confirm the Planting Soil conforms to the approved material.
 2. All testing shall be performed by the same soil lab that performed the original Planting Soil testing.
 3. Testing results shall be within 10% plus or minus of the values measured in the approved Planting Soil Mixes.
 4. Any Planting Soil that fails to meet the above criteria, if requested by the Landscape Architect, shall be removed and new soil installed.
- G. **Soil compaction testing:** following installation or modification of soil, test soil compaction with a penetrometer.
1. Maintain at the site at all times a soil cone penetrometer with pressure dial and a soil moisture meter to check soil compaction and soil moisture.
 - a. Penetrometer shall be agraTronix Soil Compaction Meter distributed by Ben Meadows, www.benmeadows.com or approved equal.
 - b. Moisture meter shall be "general digital soil moisture meter" distributed by Ben Meadows, www.benmeadows.com or approved equal.
 2. Prior to testing the soil with the penetrometer check the soil moisture and penetrometer readings in the mockup soils. Penetrometer readings are impacted by soil moisture and

- excessively wet or dry soils will read significantly lower or higher than soils at optimum moisture.
3. The penetrometer readings shall be within 20% plus or minus of the readings in the approved mockup when at similar moisture levels.
- H. Mockups: Provide mockup for each type of component per the Drawings and/or shop drawing and/or as follows:
1. Prior to installation or modification of Topsoil, site soil, Planting Soil, Planting Soil Mixes, construct at the site or layered soil assemblies, a mockup of each soil type using the means and methods and equipment proposed by the Contractor to complete the work. Installation of the mockup shall be in the presence of the Landscape Architect. The purpose of the mockup is to test the methods of installation and compaction of the soil and to serve as a benchmark for completed soil compaction and serve to calibrate penetrometer readings to the known proctor density of the mockup. The mockup shall be as follows:
 - a. Following acceptance of the soil submittals, in areas that can be protected from disturbance and further compaction, install mockups of each soil type and soil modification, 20 foot X 20 foot X the full depth of the deepest installation, using the requirements of these specifications. Compaction methods, including the type of compaction equipment and number of passes required to achieve the required compaction shall be evaluated and results measured.
 - b. Compaction in the mockup soil shall be tested using the penetrometer. A minimum of four penetrometer readings from each Planting Soil shall be taken at the specified depths of the soil profile. Record the soil moisture at each penetrometer test site. In the event that the penetrometer readings exceed the specified densities, reconstruct the mockup, adjusting the soil density to achieve the desired results. Where the modification requires ripping, tilling or fracturing soils that are over compacted, start the procedure in a new location so that the process is working on soil that is similar to the density of the expected soil.
 - c. Submit a report of the final methods of soil installation, the penetrometer and soil moisture readings to the Landscape Architect.
 - d. The mockup area may remain as part of the installed work at the end of the project if protected from further compaction, contamination or other disturbance.
 - e. Provide a protective 4 foot high fence on metal posts around each mockup to keep all work and equipment from entering the surface of the mockup area.

1.17 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses and analysis on related components.
 1. Notify Landscape 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.

1.18 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 Landscape 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 each soil to be used or amended for landscaping purposes.
 2. Procedures and Depth of Samples: According to USDA-NRCS's "Field Book for Describing and Sampling Soils."
 3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.
 4. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

1.19 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 D 698 (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 NAFT 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.

1.20 DELIVERY, STORAGE, AND HANDLING

- A. Deliver packaged products in an undamaged condition in original containers, displaying manufacturer's labels, along with instructions for handling, storing, unpacking, protecting, and installing.
- B. Deliver and store materials in manufacturer's original containers, with seals unbroken and identification labels intact until time of use.
- C. Deliver products to achieve the shortest duration of storage time as practicable.
- D. Deliver all chemical products in original, unopened containers with original labels intact and legible, which state the guaranteed chemical analysis. Store all chemicals in weather protected enclosure.
- E. Comply with manufacturer's written instructions for delivery, storage, and handling, and as required to prevent damage to products and work during construction.
- F. Store products and materials in a neat and orderly manner. Maintain clear aisles and access to work areas. Protect stored products from theft and damage. Store products above ground in weathertight, ventilated packaging or enclosures.
- G. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.
- H. Store liquids in tightly closed containers protected from freezing.
- I. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- J. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk materials with appropriate certificates.
- K. Weather: Do not mix, deliver, place or grade soils when frozen or with moisture above field capacity.
- L. Protect soil and soil stockpiles, including the stockpiles at the soil blender's yard, from wind, rain and washing that can erode soil or separate fines and coarse material, and contamination by chemicals, dust and debris that may be detrimental to plants or soil drainage. Cover stockpiles with plastic sheeting or fabric at the end of each workday.

- M. All manufactured packaged products and material shall be delivered to the site in unopened containers and stored in a dry enclosed space suitable for the material and meeting all environmental regulations. Biological additives shall be protected from extreme cold and heat. All products shall be freshly manufactured and dated for the year in which the products are to be used.
- N. Deliver all chemical amendments in original, unopened containers with original labels intact and legible, which state the guaranteed chemical analysis. Store all chemicals in weather protected enclosure.
- O. Bulk material: Coordinate delivery and storage with Landscape Architect and confine materials to neat piles in areas acceptable to Landscape Architect.

1.21 FIELD CONDITIONS

- A. It is the responsibility of the Contractor to be aware of all surface and subsurface conditions, and to notify the Landscape Architect, in writing, of any circumstances that would negatively impact the health of plantings. Do not proceed with work until unsatisfactory conditions have been corrected.
 - 1. Should subsurface drainage or soil conditions be encountered which would be detrimental to growth or survival of plant material, the Contractor shall notify the Landscape Architect in writing, stating the conditions and submit a proposal covering cost of corrections. If the Contractor fails to notify the Landscape Architect of such conditions, he/she shall remain responsible for plant material under the warrantee clause of the specifications.
 - 2. This specification requires that all Planting Soil and Irrigation (if applicable) work be completed and accepted prior to the installation of any plants.
- B. Field Measurements: Verify actual locations of all site elements and other construction contiguous with the work of this section prior to fabrication and/or installation.
- C. The work shall not occur in the presence of standing water, mud, snow, or frozen subgrade conditions. Work shall not occur while precipitation is occurring or during excessive winds, or when temperatures are outside the limits specified in this specification. Work completed during these conditions will be rejected.
- D. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- E. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
- F. Hot-Weather Requirements: Comply with hot-weather construction requirements.

1.22 EXCAVATING AND GRADING AROUND UTILITIES

- A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.
- B. Determine location of underground utilities and perform work in a manner that will avoid damage. Hand excavate as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.
- C. Notification of the utility locate services is required for all Excavation and grading deeper than 12 inches: The Contractor is responsible for knowing the location and avoiding utilities that are not covered by the local utility locator service.

1.23 OBSERVATION OF THE WORK

- A. The Landscape Architect may observe the work at any time. They may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting specifications shall be paid by the Contractor.
- B. The Landscape Architect shall be informed of the progress of the work so the work may be observed during key times in the construction process. The Landscape Architect shall be afforded sufficient time to schedule visits to the site. Failure of the Landscape Architect to make field observations shall not relieve the Contractor from meeting all the requirements of this specification.
 - 1. SOIL MOCKUP REVIEW: At the time of construction of all soil mockups (if required).
 - 2. EXISTING SOIL CONDITIONS REVIEW: Prior to the start of any soil modification that will utilize or modify the existing soil.
 - 3. EXCAVATION REVIEW: Inspect each area of excavation prior to the installation of any Planting Soil.
 - 4. DRAIN LINE INSTALLATION REVIEW: Upon completion of the installation of drain lines and prior to the installation of any Planting Soil
 - 5. COMPLETION of SOIL MODIFICATIONS REVIEW: Upon completion of all soil modification and installation of planting soil.
 - 6. COMPLETION OF FINE GRADING AND SURFACE SOIL MODIFICATIONS REVIEW: Upon completion of all surface soil modifications and fine grading but prior to the installation of shrubs, ground covers, or lawns.

1.24 FIRST WORK IN PLACE

- A. The Landscape Architect shall be informed once the first work in place has been completed for all individual elements included in this section for review to ensure the work is proceeding in accordance with the approved samples and mockups and per the Contract Documents. The Landscape Architect shall be afforded sufficient time to schedule visits to the site for review. In the event that sufficient time cannot be provided the Contractor shall provide images from multiple angles and perspectives of the work for Landscape Architect review.

1.25 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering and wear.
 - b. Separation or delamination of materials and components.
 2. Warranty Period: One year from date of Substantial Completion.

1.26 MAINTENANCE SERVICE

- A. Contractor to provide standard industry maintenance on all scope items herein until Final Acceptance.

PART 2 - PRODUCTS

2.1 PLANTING SOILS GENERAL

- A. General definition: Existing Soil or mixes of Existing Soil or Imported Topsoil, Coarse Sand, Expanded Shale, Pine Bark Fines, and/or Compost to make a new soil that meets the project goals for the indicated planting area. These will vary in Mix components and proportions as recommended by the Soils Consultant.
- B. In the event that harvesting of Existing Soil does not produce sufficient material, provide topsoil, and soil mixes that are similar to the specified soil.

2.2 IMPORTED TOPSOIL

- A. Imported Topsoil definition: Fertile, friable soil containing less than 5% total volume of the combination of debris including subsoil, refuse, roots larger than 1 inch diameter, heavy or stiff clay, stones larger than 2 inches in diameter, noxious seeds, sticks, brush, litter, or any substances deleterious to plant growth. The percent (%) of the above objects shall be controlled by source selection not by screening the soil.
- B. Topsoil shall be suitable for the germination of seeds and the support of vegetative growth. Imported Topsoil shall not contain weed seeds in quantities that cause noticeable weed infestations in the final planting beds. Imported Topsoil shall meet the following physical and chemical criteria:
1. Soil texture: USDA loam, sandy clay loam or sandy loam with clay content between 15 and 40%. And a combined clay/silt content of no more than 75%.
 2. pH value shall be between 5.5 and 7.5.
 3. Percent organic matter (OM): 2.0-8.0%, by dry weight.
 4. Soluble salt level: Less than 2 mmho/cm.
 5. Soil chemistry suitable for growing the plants specified.

6. Imported Topsoil shall not contain quack-grass rhizomes, *Agropyron Repens*, and the nut-like tubers of nutgrass, *Cyperus Esculentus*, and all other primary noxious weeds seeds in quantities that cause noticeable weed infestations in the final planting beds.
- C. Imported Topsoil shall be a harvested soil from fields or development sites. The organic content and particle size distribution shall be the result of natural soil formation. Manufactured soils where Coarse Sand, Composted organic material or chemical additives has been added to the soil to meet the requirements of this specification section shall not be acceptable. Retained soil peds shall be the same color on the inside as is visible on the outside.
- D. Provide a two gallon sample from each Imported Topsoil source with required soil testing results. The sample shall be a mixture of the random samples taken around the source stockpile or field. The soil sample shall be delivered with soil peds intact that represent the size and quantity of expected peds in the final delivered soil.

2.3 COMPOST

- A. Compost: Organic blended material, composted for a minimum of 9 months and at temperatures sufficient to break down all woody fibers, seeds and leaf structures, free of toxic materials at levels that are harmful to plants or humans. Source material shall be yard waste trimmings blended with other plant or manure based material designed to produce Compost high in fungal material.
 1. Compost shall be commercially prepared Compost and meet US Compost Council STA/TMECC criteria.
 2. Compost shall comply with the following parameters:
 - a. pH: 5.5 - 8.0.
 - b. Soil salt (electrical conductivity): maximum 5 dS/m (mmhos/cm).
 - c. Moisture content %, wet weight basis: 30 – 60.
 - d. Particle size, dry weight basis: 98% pass through 3/4 inch screen or smear.
 - e. Stability carbon dioxide evolution rate: mg CO₂-C/ g OM/ day < 2.
 - f. Solvita maturity test: > 6.
 - g. Physical contaminants (inerts), %, dry weight basis: <1%.
 - h. Chemical contaminants, mg/kg (ppm): meet or exceed US EPA Class A standard, 40CFR § 503.13, Tables 1 and 3 levels.
 - i. Biological contaminants select pathogens fecal coliform bacteria, or salmonella, meet or exceed US EPA Class A standard, 40 CFR § 503.32(a) level requirements.
- B. Provide a two gallon sample with manufacturer's literature and material certification that the product meets the requirements.

2.4 PINE BARK FINES

- A. Pine Bark Fines: Aged Southern Yellow Pine bark finely ground, 1/2" screened, and aged with cambium and wood fiber removed.
 1. Pine Bark Fines shall comply with the following parameters:
 - a. pH: 4.0 - 6.0.

- b. Soil salt (electrical conductivity): maximum 1.0 dS/m (mmhos/cm).
- c. Moisture content %, wet weight basis: 30 – 60.
- d. C:N
- e. Bulk Density: 500-700 lbs/cy

2. Provide Pine Bark Fines with the following particle size distribution:

<u>Sieve</u>	<u>Percent passing</u>
1/2 inch (12.7mm)	85-100
3/8 inch (9.5mm)	60-80
1/4 inch (6.35mm)	20-40
No 4 (4.75mm)	10-25
No 8 (2.38mm)	5-10
No 18 (1.0mm)	0-5
No 35 (0.5mm)	<5

- B. Provide a two gallon sample manufacturer’s literature and material certification that the product meets the requirements.

2.5 COARSE SAND

- A. Clean, washed, sand, free of toxic materials

- 1. Coarse concrete sand, ASTM C-33 Fine Aggregate, with a Coefficient of Uniformity less than 4 and Fines Modulus Index of 2.8 to 3.2.
- 2. Coarse Sands shall be clean, sharp, natural Coarse Sands free of limestone, shale and slate particles. Manufactured Coarse Sand shall not be permitted.
- 3. pH shall be lower than 7.0.
- 4. Provide Coarse Sand with the following particle size distribution:

<u>Sieve</u>	<u>Percent passing</u>
3/8 inch (9.5mm)	100
No 4 (4.75mm)	95-100
No 8 (2.38mm)	80-100
No 16 (1.18mm)	50-85
No 30 (.60mm)	25-60
No 50 (.30mm)	10-30
No100 (.15mm)	2-10
No 200 (0.75mm)	2-5

- B. Provide a two gallon sample with manufacturer’s literature and material certification that the product meets the requirements.

2.6 LIGHTWEIGHT AGGREGATE

- A. Light Weight Aggregate: Expanded Clay, Slate, or Shale, rotary kiln fired, with the following properties:

1. Aggregate size shall be 5/8" to #4 size, and shall conform to the following sieve analysis:

<u>Sieve Size</u>	<u>Percent Passing</u>
1/2" (12.7mm)	90-100
3/8" (9.51mm)	40-80
#4 (4.76mm)	0-20
#8 (2.38mm)	0-10

- B. Light Weight Aggregate shall be as supplied by:

1. Hydrocks (www.hydrocks.com)
2. Haydite (www.hphaydite.com)

- C. Provide manufacturer's literature and material certification that the product meets the requirements.

2.7 FERTILIZER AMENDMENTS

- A. Fertilizer for planting shall be organic, slow release fertilizer with a salt index of 25 or less. The majority of the nutrient elements are from organic sources. Final fertilizer selections shall be based on the soil testing and recommendations of the Soils Consultant.
- B. Provide manufacturer's literature and material certification that the product meets the requirements.

2.8 LIME

- A. ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:
 1. Class: Class T, with a minimum 99 percent passing through No. 8 (2.36-mm) sieve and a minimum 75 percent passing through No. 60 (0.25-mm) sieve.
 2. Provide lime in form of dolomitic limestone.
- B. Provide manufacturer's literature and material certification that the product meets the requirements.

2.9 BIOLOGICAL SOIL FERTILITY AMENDMENTS

- A. Vermamax™ - Organic Pre-Plant Fertilizer Amendment. Apply at half the label rates for each plant type. Apply 40lbs per 1000sf for turf areas and annual bedding areas.
 1. Sustainable Environmental Consultants
Phone: 816-383-4578
Email: cdixon@sustainableenviro.com
- B. VermaPlex™ - Liquid Soil Inoculant Amendment. Apply at specified rates for each plant type or planting area.

1. Sustainable Environmental Consultants
Phone: 816-383-4578
Email: cdixon@sustainableenviro.com

- C. Nutri-Cast™ - Granular Pre-Plant Bio-Stimulant Amendment with biological nitrogen fixation bacteria. Apply at specified rates for each plant type or planting area.

1. Sustainable Environmental Consultants
Phone: 816-383-4578
Email: cdixon@sustainableenviro.com

2.10 PRE-EMERGENT HERBICIDES

- A. Chemical herbicides are designed to prevent seeds of selective plants from germinating. Exact type of herbicide shall be based on the specific plants to be controlled and the most effective date of application.
- B. Submit report of expected weed problems and the recommendation of the most effective control for approval by Landscape Architect. Provide manufacturer's literature and material certification that the product meets the requirements.

2.11 EXISTING SOIL (SOIL SUITABLE FOR PLANTING WITH INDICATED MODIFICATION)

- A. General definition: Surface soil in the areas designated on the soils plan as Existing Soil or Modified Existing Soil, that has been altered and or graded before or during the construction process but still considered acceptable for planting and long term health of the plants specified with the proposed modifications. Modifications respond to the soil problems expected or encountered. The Landscape Architect shall verify that the soil in the designated areas is suitable for modification at the beginning of planting bed preparation work in that area.
 1. The Landscape Architect shall verify that the soil in the designated areas is suitable for the specified modification at the beginning of planting bed preparation work in that area. In the event that the work of this project construction has damaged the existing soil in areas designated for modification to the point where the soil is no longer suitable to support the plants specified with the specified modification, the Landscape Architect may require further modification of the damaged soil up to an including removal and replacement with soil of equal quality to the soil that would have resulted from the modification. Damage may include further compaction, contamination, grading, creation of hard pan or drainage problem, and loss of the O, and or A horizon.
 2. General requirements for all soil modifications:
 - a. Make appropriate adjustments based on the soil testing and recommendations of the Soils Consultant
 - b. Unless otherwise instructed, remove all existing plants, root thatch, and non-soil debris from the surface of the soil using equipment that does not add significantly to the compaction in the soil. Glyphosate may be used per manufacturer's label.
 - c. All soil grading, tilling and loosening must be completed at times when the soil moisture is below field capacity. Allow soil to drain for at least two days after any

rain event more than 1 inch in 24 hours or long enough so that the soil does not make the hand muddy when squeezed.

- d. Provide pre-emergent weed control after the soil work is complete and plants planted but prior to adding mulch to the surface, if indicated by weed type and degree of threat.

2.12 EXISTING SOIL AND MODIFIED EXISTING SOIL – STOCKPILED, AND REUSED

- A. Description of condition to be modified: Existing soil that is suitable for reuse as Planting Soil but is in the wrong place or elevation, or cannot be adequately protected during construction. Soil is to be harvested, stockpiled and reused as planting soils with or without further modifications as indicated.

1. Modifications:

- a. Excavate existing soil from the areas and to depths designated on the drawings. Stockpile in zones noted on the drawings or in areas proposed by the Contractor.
- b. Prepare a soil stock pile plan for approval.
- c. Excavate soil using equipment and methods to preserve the clumps and peds in the soil. Generally this means using the largest piece of equipment that is practical for the project size and scope.
- d. Protect stock piles from erosion by compacting or tracking the soil surface, covering with breathable fabric or planting with annual grasses as appropriate for the season location, length of expected time of storage.
- e. Re-spread soil as required in Part 3 of this specification.

2.13 MODIFIED EXISTING SOIL – COMPACTED SURFACE SOIL

- A. Description of condition to be modified: Surface soil compaction to a maximum of 6 inches deep from traffic or light grading. Original A horizon may be previously removed or graded but lower profile intact with acceptable compaction levels and limited grading. The soil organic matter, pH and chemistry in the A horizon may not be suitable for the proposed plants and may need to be modified as required.

1. Modifications:

- a. Till top 6 inches or deeper of the soil surface, with a *rototiller*, *spade tiller*, ripper or agricultural plow. Spread 2 - 3 inches of Lightweight Aggregate on the surface of the tilled soil and make any chemical adjustment as recommended by the soil test.
- b. Till or disk the Compost into the loosened soil. Smooth out grades with a drag rake or drag slip.
- c. Or as recommended by the Soils Consultant.

2.14 MODIFIED EXISTING SOIL – COMPACTED SUBSOIL

- A. Description of condition to be modified: Deep soil compaction resulting from previous grading, filling, dynamic or static compaction forces. Original A horizon likely removed or buried. The

soil organic matter, pH and chemistry in the A horizon is likely not suitable for the proposed plants and should be modified as required.

1. Soil Ripping:
 - a. Step One: After grading and removing all plants and debris from the surface, using a tracked dozer or similar large grading equipment, loosen the soil by dragging a ripping shank or chisel thru the soil to depths of 24 inches with ripping shanks spaced 18 inches or less apart in two directions. The number of shanks per pull is dependent on the degree of soil compaction and the size of the dozer.
 - b. Step Two: Spread 3-4 inches of Compost over the ripped area and till into the top 6 inches of the soil surface.
 - c. Or as recommended by the Soils Consultant
2. Soil Fracturing:
 - a. Step One: After grading and removing all plants and debris from the surface spread 2-3 inches of Compost over the surface of the soil. Loosen the soil to a depth of 18-24 inches, using a backhoe to dig into the soil through the Compost. Lift and then drop the loosened soil immediately back into the hole. The bucket then moves to the adjacent soil and repeats the process until the entire area indicated is has been loosened.
 - b. Step Two: Spread 3-4 inches of Compost over the ripped area and till into the top 6 inches of the soil surface.
 - c. Or as recommended by the Soils Consultant
3. Following soil ripping or fracturing the average penetration resistance should be less than 250 psi to the depth of the ripping or fracturing.
4. Do not start any planting into ripped or fractured soil until soil has settled or leave grades sufficiently high to anticipate settlement of 10-15% of ripped or fractured soil depth.

2.15 CUSTOM BLENDED SOILS

A. Planting Soil:

1. Base soil texture: USDA loam, sandy clay loam or sandy loam with clay content between 15 and 40%. And a combined clay/silt content of no more than 75%.
2. Blended soil components:
 - a. Base Soil meeting Base Soil Texture Requirements:
 - 1) 60% by volume.
 - b. Coarse Sand:
 - 1) 20% by volume.
 - c. Compost:
 - 1) 20% by volume.
3. Blended pH value shall be between 5.5 and 8.0.
4. Blended percent organic matter (OM): 2.0-8.0%, by dry weight.
5. Blended soluble salt level: Less than 2 mmho/cm.
6. Soil chemistry suitable for growing the plants specified.

7. Imported blended soil shall not contain quack-grass rhizomes, *Agropyron Repens*, and the nut-like tubers of nutgrass, *Cyperus Esculentus*, and all other primary noxious weeds seeds in quantities that cause noticeable weed infestations in the final planting beds.

B. Lawn Soil:

1. Base soil texture: USDA loam, sandy clay loam or sandy loam with clay content between 15 and 40%. And a combined clay/silt content of no more than 75%.
2. Blended soil components:
 - a. Base Soil meeting Base Soil Texture Requirements:
 - 1) 30% volume.
 - b. Coarse Sand:
 - 1) 60% by volume.
 - c. Compost:
 - 1) 10% by volume.
3. Blended pH value shall be between 5.5 and 8.0.
4. Blended percent organic matter (OM): 2.0-8.0%, by dry weight.
5. Blended soluble salt level: Less than 2 mmho/cm.
6. Soil chemistry suitable for growing the plants specified.
7. Imported blended soil shall not contain quack-grass rhizomes, *Agropyron Repens*, and the nut-like tubers of nutgrass, *Cyperus Esculentus*, and all other primary noxious weeds seeds in quantities that cause noticeable weed infestations in the final planting beds.

C. Bioswale Soil:

1. Base soil texture: USDA loam, sandy clay loam or sandy loam with clay content between 15 and 40%. And a combined clay/silt content of no more than 75%.
2. Blended soil components:
 - a. Base Soil meeting Base Soil Texture Requirements:
 - 1) 20% by volume.
 - b. Coarse Sand:
 - 1) 80% by volume.
 - c. Compost:
 - 1) 00% by volume.
3. Blended pH value shall be between 5.5 and 8.0.
4. Blended percent organic matter (OM): 2.0-8.0%, by dry weight.
5. Blended soluble salt level: Less than 2 mmho/cm.
6. Soil chemistry suitable for growing the plants specified.
7. Imported blended soil shall not contain quack-grass rhizomes, *Agropyron Repens*, and the nut-like tubers of nutgrass, *Cyperus Esculentus*, and all other primary noxious weeds seeds in quantities that cause noticeable weed infestations in the final planting beds.

2.16 PRE-MANUFACTURED SOILS

1. PM-35 Planter Mix (Type 1A = Top 12 inches of planting profiles):
 - a. Supplied by Midwest Trading, PO Box 398 Maple Park, IL 60151. 630-3651990.
 - a) A PH range of 5.5-7 shall be met, a max PH of 7 shall be met. Provide PH testing data to ensure mix and all mix components conforms to requirements.

- b) Provide separate PH testing data for the topsoil component to be incorporated into the overall media blend.
2. Midwest Intensive Media (Type 1B = Bottom portion of planting profiles):
 - a. Supplied by Midwest Trading, PO Box 398 Maple Park, IL 60151. 630-3651990.
 - 1) A PH range of 5.5-7 shall be met, a max PH of 7 shall be met. Provide PH testing data to ensure mix and all mix components conforms to requirements.
3. Midwest Roof Turf Media (Type 2 = Full depth lawn soil profiles):
 - a. Supplied by Midwest Trading, PO Box 398 Maple Park, IL 60151. 630-3651990.
 - 1) A PH range of 5.5-7 shall be met, a max PH of 7 shall be met. Provide PH testing data to ensure mix and all mix components conforms to requirements.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Prior to installation examine site to confirm that existing conditions are satisfactory for the work of this section to proceed.
- B. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope toward the under drain lines as shown on the drawings.
- C. Confirm that no adverse drainage conditions are present.
- D. Confirm that no conditions are present which are detrimental to plant growth.
- E. Confirm that utility work has been completed per the drawings.
- F. If unsatisfactory conditions are encountered, notify the Landscape Architect immediately to determine corrective action prior to proceeding.

3.2 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.

3.3 EXAMINATION

- A. Prior to installation of Planting Soil, examine site to confirm that existing conditions are satisfactory for the work of this section to proceed.

1. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope toward the under drain lines as shown on the drawings.
 2. Confirm that surface all areas of the to be filled with Planting Soil are free of construction debris, refuse, compressible or biodegradable materials, stones greater than 2 inches diameter, soil crusting films of silt or clay that reduces or stops drainage from the Planting Soil into the subsoil; and/or standing water. Remove unsuitable material from the site.
 3. Confirm that no adverse drainage conditions are present.
 4. Confirm that no conditions are present which are detrimental to plant growth.
 5. Confirm that utility work has been completed per the drawings.
 6. Confirm that irrigation work, which is shown to be installed below prepared soil levels, has been completed.
- B. If unsatisfactory conditions are encountered, notify the Landscape Architect immediately to determine corrective action before proceeding.

3.4 COORDINATION WITH PROJECT WORK

- A. The Contractor is responsible for investigating, and being aware of, the work requirements of their sub-contractors and other contractors. The Contractor shall coordinate with all other work that may impact the completion of the work herein.
- B. The Contractor shall coordinate with all other work that may impact the completion of the work.
- C. Prior to the start of work, prepare a detailed schedule of the work for coordination with other trades.
- D. Coordinate the relocation of any irrigation lines, heads or the conduits of other utility lines that are in conflict with tree locations. Root balls shall not be altered to fit around lines. Notify the Landscape Architect of any conflicts encountered.

3.5 SITE PREPARATION

- A. Excavate to the proposed subgrade. Maintain all required angles of repose of the adjacent materials as shown on the drawings or as required by this specification. Do not over excavate compacted subgrades of adjacent pavement or structures. Maintain a supporting 1:1 side slope of compacted subgrade material along the edges of all paving and structures where the bottom of the paving or structure is above the bottom elevation of the excavated planting area.
- B. Remove all construction debris and material including any construction materials from the subgrade.
- C. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope approximately parallel to the finished grade and/or toward the subsurface drain lines as shown on the drawings.
- D. In areas where Planting Soil is to be spread, confirm subgrade has been scarified.

- E. Protect adjacent walls, walks and utilities from damage or staining by the soil. Use 1/2 inch plywood and or plastic sheeting as directed to cover existing concrete, metal and masonry work and other items as directed during the progress of the work.
 - 1. At the end of each working day, clean up any soil or dirt spilled on any paved surface.
 - 2. Any damage to the paving or site features or work shall be repaired at the Contractor's expense.

3.6 SOIL MOISTURE

- A. Volumetric soil moisture level, in both the Planting Soil and the root balls of all plants, prior to, during and after planting shall be above permanent wilt point and below field capacity for each type of soil texture within the following ranges.

Soil texture	Permanent wilting point	Field capacity
Sand, Loamy sand, Sandy loam	5-8%	12-18%
Loam, Sandy clay, Sandy clay loam	14-25%	27-36%
Clay loam, Silt loam	11-22%	31-36%
Silty clay, Silty clay loam	22-27%	38-41%

Note the above chart is not applicable to soils with Light Weight Aggregate. Ranges of appropriate soil moisture for these soils shall be developed once the soils are in place and can be tested with the moisture meter.

- B. The Contractor shall confirm the soil moisture levels with a moisture meter (Digital Soil Moisture Meter, DSMM500 by General Specialty Tools and Instruments, or approved equivalent). If moisture is found to be too low, the planting holes shall be filled with water and allowed to drain before starting any planting operations. If the moisture is too high, suspend planting operations until the soil moisture drains to below field capacity.

3.7 EXISTING SOIL MODIFICATION

- A. Follow the requirements for modifying existing soil as indicated in Part 2 for the different types of soil modifications. The extent of the areas of different soil modification types as directed by the Soils Consultant.

3.8 PLANTING SOIL AND PLANTING SOIL MIX INSTALLATION

- A. Prior to installing any Planting Soil from stockpiles or Planting Soil Mixes blended off site, the Landscape Architect shall approve the condition of the subgrade and the previously installed subgrade preparation and the installation of subsurface drainage.

- B. All equipment utilized to install or grade Planting Soils shall be wide track or balloon tire machines rated with a ground pressure of 4 PSI or less. All grading and soil delivery equipment shall have buckets equipped with 6 inch long teeth to scarify any soil that becomes compacted.
- C. In areas of soil installation above existing subsoil, loosen the subgrade material prior to installing Planting Soil.
 - 1. Loosen the subsoil of the subgrade to a depth of 3 – 6 inches with the teeth of the back hoe or loader bucket, tiller or other suitable device.
 - 2. Immediately install the Planting Soil. Protect the loosened area from traffic. DO NOT allow the loosened subgrade to become compacted.
 - 3. In the event that the loosened area becomes overly compacted, loosen the area again prior to installing the Planting Soil.
- D. Install the Planting Soil in 12 - 18 inch lifts to the required depths. Apply compacting forces to each lift as required to attain the required compaction. Scarify the top of each lift prior to adding more Planting Soil.
- E. Phase work such that equipment to deliver or grade soil does not have to operate over previously installed Planting Soil. Work in rows of lifts the width of the extension of the bucket on the loader. Install all lifts in one row before proceeding to the next. Work out from the furthest part of each bed from the soil delivery point to the edge of the each bed area.
- F. Where possible place large trees first and fill Planting Soil around the root ball.
- G. Installing soil with soil or mulch blowers or soil slingers shall not be permitted due to the over mixing and soil ped breakdown cause by this type of equipment.
- H. Where travel over installed soil is unavoidable, limit paths of traffic to reduce the impact of compaction in Planting Soil. Each time equipment passes over the installed soil it shall reverse out of the area along the same path with the teeth of the bucket dropped to scarify the soil. Comply with the paragraph “Compaction Reduction” (section 3.9) in the event that soil becomes over compacted.
- I. The depths and grades shown on the drawings are the final grades after settlement and shrinkage of the organic material. The Contractor shall install the Planting Soil at a higher level to anticipate this reduction of Planting Soil volume. A minimum settlement of approximately 10 - 15% of the soil depth is expected. All grade increases are assumed to be as measured prior to addition of surface Compost till layer, mulch, or sod.

3.9 COMPACTION REQUIREMENTS FOR INSTALLED OR MODIFIED PLANTING SOIL

- A. Compact installed Planting Soil to the compaction rates indicated and using the methods approved for the soil mockup. Compact each soil lift as the soil is installed.
- B. Existing soil that is modified by tilling, ripping or fracturing shall have a density to the depth of the modification, after completion of the loosening, such that the penetrometer reads approximately 75 to 250 psi at soil moisture approximately the mid-point between wilting point

and field capacity. This will be approximately between 75 and 82% of maximum dry density standard proctor.

- C. Installed Planting Soil Mix and re-spread existing soil shall have a soil density through the required depth of the installed layers of soil, such that the penetrometer reads approximately 75 to 250 psi at soil moisture approximately the mid-point between wilt point and field capacity. This will be approximately between 75 and 82% of maximum dry density standard proctor.
- D. Planting Soil compaction shall be tested at each lift using a penetrometer calibrated to the mockup soil and its moisture level. The same penetrometer and moisture meter used for the testing of the mockup shall be used to test installed soil throughout the work.
- E. Maintain moisture conditions within the Planting Soil during installation or modification to allow for satisfactory compaction. Suspend operations if the Planting Soil becomes wet. Apply water if the soil is overly dry.
- F. Provide adequate equipment to achieve consistent and uniform compaction of the Planting Soils. Use the smallest equipment that can reasonably perform the task of spreading and compaction. Use the same equipment and methods of compaction used to construct the Planting Soil mockup.
- G. Do not pass motorized equipment over previously installed and compacted soil except as authorized below.
 - 1. Light weight equipment such as trenching machines or motorized wheel barrows are permitted to pass over finished soil work.
 - 2. If work after the installation and compaction of soil compacts the soil to levels greater than the above requirements, follow the requirements of the paragraph "Over Compaction Reduction" below.

3.10 OVER COMPACTION REDUCTION

- A. Any soil that becomes compacted to a density greater than the specified density and/or the density in the approved mockup shall be dug up and reinstalled. This requirement includes compaction caused by other subcontractors after the Planting Soil is installed and approved.
- B. Surface rototilling shall not be considered adequate to reduce over compaction at levels 6 inches or greater below finished grade.

3.11 INSTALLATION OF CHEMICAL and FERTILIZER AMENDMENTS

- A. Following the installation of each soil and prior to fine grading and installation of the Compost till layer (if included in this specification), apply chemical and fertilizer additives as directed by the Soils Consultant, and appropriate to the soil and specific plants to be installed.
- B. Types, application rates and methods of application shall be approved by the Soils Consultant prior to any applications.

3.12 FINE GRADING

- A. The Landscape Architect shall approve all rough grading prior to the installation of organic matter, fine grading, planting, and mulching.
- B. Grade the finish surface of all planted areas to meet the grades shown on the drawings, allowing the finished grades to remain higher (10 – 15% of depth of soil modification) than the grades on the grading plan, as defined in paragraph Planting Soil Installation, to anticipate settlement over the first year.
- C. Utilize hand equipment or small garden tractors with rakes or buckets with teeth for fine grading to keep surface rough without further compaction. Do not use the bottom of a loader bucket that will cause the finished grade the smooth and or slightly compress.
- D. Provide for positive drainage from all areas toward the existing inlets, drainage structures and or the edges of planting beds. Adjust grades as directed to reflect actual constructed field conditions of paving, wall and inlet elevations. Notify the Landscape Architect in the event that conditions make it impossible to achieve positive drainage.
- E. Provide smooth, rounded transitions between slopes of different gradients and direction. Modify the grade so that the finish grade before adding mulch and after settlement is one or two inches below all paving surfaces or as directed by the drawings.
- F. Fill all dips and remove any bumps in the overall plane of the slope. The tolerance for dips and bumps in shrub and ground cover planting areas shall be a 2 inches deviation from the plane in 10 feet. The tolerance for dips and bumps in lawn areas shall be a 1 inch deviation from the plane in 10 feet.

3.13 INSTALLATION OF COMPOST TILL LAYER (BASED ON SOIL TESTING AND AS REQUIRED BY SOILS CONSULTANT)

- A. After Planting Soil Mixes are installed in planting bed areas noted on the drawing and just prior to the installation of shrub or groundcover plantings, spread 2 - 3 inches of Compost over the beds and roto till into the top 4 - 6 inches of the Planting Soil. This step will raise grades slightly above the grades required in paragraph “Fine Grading”. This specification anticipates that the raise in grade due to this tilling will settle within a few months after installation as Compost breaks down. Additional settlement as defined in paragraph “Planting Soil and Planting Soil Mix installation” must still be accounted for in the setting of final grades.

3.14 GRADE AND ELEVATION CONTROL

- A. Provide grade and elevation control during installation of Planting Soil. Utilize grade stakes, surveying equipment, and other means and methods to assure that grades and contours conform to the grades indicated on the plans.

3.15 INSTALLATION TOLERANCES

- A. Final soil installation after planting should be within 1/2 inch of grades shown on the grading plan.

3.16 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

3.17 REPAIR AND REPLACEMENT

- A. General: Repair or replace that is damaged by construction operations, in a manner approved by Landscape Architect.

3.18 WASTE HANDLING

- A. General: Handle waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

3.19 CLEANING

- A. The contractor should clean the job site and remove any excess materials. Coordinate with Owner for storage locations for any Attic Stock materials where applicable.
- B. During installation, keep the site free of trash, pavements reasonably clean and work area in an orderly condition at the end of each day. Remove trash and debris in containers from the site no less than once a week.
 - 1. Immediately clean up any spilled or tracked soil, fuel, oil, trash or debris deposited by the Contractor from all surfaces within the project or on public right of ways and neighboring property.
- C. Once installation is complete, wash all soil from pavements and other structures. Ensure that mulch is confined to planting beds and that all tags and flagging tape are removed from the site. The Landscape Architect seals are to remain on the trees and removed at the end of the warranty period.
 - 1. Make all repairs to grades, ruts, and damage to the work or other work at the site.
 - 2. Remove and dispose of all excess Planting Soil, subsoil, mulch, plants, packaging, and other material brought to the site by the Contractor.

3.20 PLANTING SOIL AND MODIFIED EXISTING SOIL PROTECTION

- A. The Contractor shall protect installed and/or modified Planting Soil from damage including contamination and over compaction due to other soil installation, planting operations, and

operations by other Contractors or trespassers. Maintain protection during installation until acceptance. Utilize fencing and matting as required or directed to protect the finished soil work. Treat, repair or replace damaged Planting Soil immediately.

- B. Loosen compacted Planting Soil and replace Planting Soil that has become contaminated as determined by the Landscape Architect. Planting Soil shall be loosened or replaced at no expense to the Owner.
 - 1. Till and restore grades to all soil that has been driven over or compacted during the installation of plants.
 - 2. Where modified existing soil has become contaminated and needs to be replaced, provide imported soil that is of similar composition, depth and density as the soil that was removed.

3.21 PROTECTION

- A. The Contractor shall protect planting and related work and other site work from damage due to planting operations, operations by other Contractors or trespassers.
 - 1. Maintain protection during installation until the date of plant acceptance (see specifications section – Planting). Treat, repair or replace damaged work immediately.
 - 2. Provide temporary erosion control as needed to stop soil erosion until the site is stabilized with mulch, plantings or turf.
- B. Damage done by the Contractor, or any of their subcontractors to existing or installed plants, or any other parts of the work or existing features to remain, including large existing trees, soil, paving, utilities, lighting, irrigation, other finished work and surfaces including those on adjacent property, shall be cleaned, repaired or replaced by the Contractor at no expense to the Owner. The Landscape Architect shall determine when such cleaning, replacement or repair is satisfactory.
- C. Substantial Completion Acceptance
 - 1. Upon written notice from the Contractor, the Landscape Architect shall review the work and make a determination if the work is substantially complete.
 - 2. The date of substantial completion of the planting soil shall be the date when the Landscape Architect accepts that all work in Planting, Planting Soil, and Irrigation installation sections is complete.

3.22 MAINTENANCE SERVICE

- A. Maintenance Service: Provide maintenance by skilled employees of Installer or approved Subcontractor. Maintain as required in "Maintenance" Article. Begin maintenance immediately after scope is installed and continue until final acceptance.

3.23 DEMONSTRATION AND TRAINING

- A. Engage a manufacturer-authorized service representative and/or other authorized professional to train Owner's maintenance personnel to adjust and operate all components herein.
 - 1. Train Owner's maintenance personnel in proper maintenance procedures for all components herein.

3.24 FINAL ACCEPTANCE / SOIL SETTLEMENT

- A. At the end of the plant warranty and maintenance period, (see Specification section - Planting) the Landscape Architect shall inspect the soil installation work and establish that all provisions of the contract are complete and the work is satisfactory.
 - 1. Restore any soil settlement and or erosion areas to the grades shown on the drawings. When restoring soil grades remove and plants and mulch and add soil before restoring the planting. Do not add soil over the root balls of plants or on top of mulch.
- B. Failure to pass inspection: If the work fails to pass final inspection, any subsequent inspections must be rescheduled as per above. The cost to the Owner for additional inspections will be charged to the Contractor at the prevailing hourly rate of the inspector.

3.25 APPENDIX TO 32 91 13 PLANTING SOIL

- 1. Existing soil test data not included in this specification.

END OF SECTION - 32 91 13

SECTION 32 92 00 - 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. Sodding.

- B. Related Requirements:

- 1. Section 32 84 00 "Planting Irrigation."
 - 2. Section 32 91 13 "Soil Preparation."
 - 3. Section 32 93 00 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.
 - 4. Section 33 46 00 "Subdrainage" for below-grade drainage of landscaped areas.

1.3 CONTRACT DOCUMENTS

- A. Shall consist of specifications and its general conditions and the drawings. The intent of these documents is to include all labor, materials, and services necessary for the proper execution of the work. The documents are to be considered as one. Whatever is called for by any parts shall be as binding as if called for in all parts.

1.4 VERIFICATION

- A. All scaled dimensions on the drawings are approximate. Before proceeding with any work, the Contractor shall carefully check and verify all dimensions and quantities, and shall immediately inform the Landscape Architect of any discrepancies between the information on the drawings and the actual conditions, refraining from doing any work in said areas until given approval to do so by the Landscape Architect.

1.5 PERMITS, FEES AND REGULATIONS

- A. Permits: The Contractor shall secure and pay for all permits, inspections, and certificates of inspection of any governmental and inspection body having jurisdiction over all or any part of

the work included under this section and/or such inspections etc., required by these specifications.

- B. Fees: The Contractor shall secure and pay for all fees and assessments in connection with the work under this contract and shall include this cost in its bid and contract price.
- C. The Contractor shall comply with all laws and ordinances bearing on the operation or conduct of the work as drawn and specified. If the Contractor observes that a conflict exist between permit requirements and the work outlined in the contract documents, the Contractor shall promptly notify the Landscape Architect in writing including a description of any necessary changes and changes to the contract price resulting from changes in the work.
- D. Wherever references are made to standards or codes in accordance with which work is to be performed or tested, the edition or revision of the standards and codes current on the effective date of this contract shall apply, unless otherwise expressly set forth.
- E. In case of conflict among any referenced standards or codes or between any referenced standards and codes and the specifications, the more restrictive standard shall apply or Landscape Architect shall determine which shall govern.

1.6 PROTECTION OF WORK, PROPERTY AND PERSON

- A. The Contractor shall adequately protect the work, adjacent property, and the public, and shall be responsible for any damages or injury due to the Contractor's actions.

1.7 CORRECTION OF WORK

- A. The Contractor shall re-execute any work that fails to conform to the requirements of the contract and shall remedy defects due to faulty materials or workmanship upon written notice from the Landscape Architect, at the soonest possible time that can be coordinated with other work and seasonal weather demands, but not more than 180 (one hundred and eighty) days after notification.

1.8 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

- D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 32 91 13 "Soil Preparation" and drawing designations for planting soils.
- E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.9 PRE-INSTALLATION MEETINGS

- A. Pre-installation Meeting: Conduct meeting at Project Site, Manufacturer's Facility of Fabricator's Shop. Confirm with Owner and Landscape Architect 14 days prior to conference.
 - 1. Before submitting submittals, review submittals, mockup and other requirements of this section and examine procedures for ensuring quality of the scope herein. Require representatives of each entity directly concerned with the scope herein, including but not limited to, the following:
 - a. Contractor's superintendent.
 - b. Subcontractor.
 - c. Special Subcontractor.
 - d. Independent testing agency responsible for testing.
 - e. Product manufacturer and/or local representative.
 - f. Authority Having Jurisdiction.
 - g. Landscape Architect.
 - 2. Review methods and procedures related to the work of this section, including but not limited to, the following:
 - a. Responsibilities of each party.
 - b. Coordination of Landscape Architect's review of the work, including but not limited to:
 - 1) Site or Shop Visits to Review Samples and Mockups
 - 2) Site Visits to Observe General Construction Progress
 - 3) Site or Shop Visits to Review Fabrication Progress
 - 4) Site Visits to Review First Work In Place
 - 5) Site Visits for Punch List Review
 - 6) Site Visits for Punch List Completion Review
 - 7) Site Visit for Warranty Review
 - c. Lines of authority and communication for the project. Procedures for resolution of any project document ambiguity.
 - d. Methods for documenting, reporting, and distributing documents and reports.
 - e. Proposed sources of materials.
 - f. Procedures for packaging and storing archive samples.
 - g. Review of the time schedule for all installation and testing. Schedule of workdays and/or starting times if third party testing verification is required.
 - h. Quality control.
 - i. Temperature and weather limitations. Installation procedures for adverse weather conditions. Defining acceptable subgrade or ambient moisture and temperature conditions for working during installation.
 - j. Subgrade conditions, dewatering responsibilities, and subgrade maintenance plan.
 - k. Deployment techniques including allowable subgrade conditions.

- l. Construction, material placement, and backfilling.
- m. Requirements for protecting work, including restriction of traffic and adjacent work impacting during installation period and for remainder of construction period.
- n. Measurement and payment schedules.
- o. Health and safety.
- p. Procedures and responsibilities for preparation and submission of as-built drawings.

1.10 COORDINATION

- A. Refer to Division 1 Requirements.
- B. The Contractor shall coordinate the work with all trades and appropriate sections of the construction specifications as necessary to ensure proper provisions for the work of this section.
- C. The Contractor shall be responsible for the protection of the Owner's property from injury or loss due to its work. All damage to existing property (building, utilities, pavement, etc.) or planting (trees, shrubs, lawn or ground cover) caused by the Contractor during its operation or as a result of malfunction of installed work during the guarantee period shall be repaired at the Contractor's expense.
- D. The Contractor shall fully inform itself regarding any available space limitations and unusual requirements, for the installation of all materials and work furnished under this section. Although the location of equipment may be shown on the drawings in certain positions, the Contractor shall confirm all locations.
- E. Contractor shall also be guided by the Landscape Architectural details and conditions at the job, correlating its work with that of the other sections and other trades, with discrepancies and interferences being brought to the attention of the Architect for resolution prior to proceeding with the work.

1.11 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Manufacturer's Product Literature and Specification Data.
 2. Manufacturer's written instructions for recommended maintenance practices.
 3. Color and finish samples for verification and selection.
 4. Written manufacturer's warranty.
 5. Product liability insurance certificate with project owner as certificate holder.
 6. MSDS for items in Part 2 "Products."
- B. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.
- C. Samples for Verification: For each type of selection made above provide a final sample.

- D. Shop Drawings: Prepared by or under the supervision of a qualified professional, detailing fabrication and assembly.
 - 1. Submit shop drawings within a reasonable time so as not to delay the start of material fabrication and installation.
 - 2. Submit shop drawings per above allowing a minimum review time of 10 business days for review and response. Per above, also allow enough time for revisions and resubmittal where reasonably predictable.
 - 3. Shop drawings shall show the proposed layout identifying all components and details based on field verified conditions and measurements.

1.12 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, Fabricator, Manufacturer and Testing agency.
- B. Material Certificates: For each of the following, signed by manufacturers:
 - 1. For all materials.
- C. 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 or plugs. Include identification of source and name and telephone number of supplier.
- D. Material Test Reports: For the following, from a qualified testing agency:
 - 1. For all materials.
- E. Product Certificates: For fertilizers, from manufacturer.
- F. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.
- G. Preconstruction test reports.
- H. Source quality-control test reports.
 - A. Field quality-control and special inspection reports.
 - B. Minutes of pre-installation conference.
 - C. Maintenance Instructions.
 - D. Warranty: Written manufacturer's warranty.

1.13 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf and meadows during a calendar year. Submit before expiration of required maintenance periods.

1.14 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Authorities Having Jurisdiction for all work included in this section.
- B. Codes and Standards: Conform work to all applicable codes and standards.
- C. Manufacturer Qualifications: Provide manufacturer qualifications as follows:
 - 1. Submit a list of ten completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.
 - 2. Submit qualifications of manufacturer.
 - 3. Submit manufacturer's quality control program.
 - 4. Submit example of Material Warranty and any other applicable warranties.
- D. Installer Qualifications Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf and meadow establishment.
 - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 - 2. Experience: Three years' experience in turf installation in addition to requirements in Section 01 40 00 "Quality Requirements."
 - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
 - a. Landscape Industry Certified Technician - Exterior.
 - b. Landscape Industry Certified Lawncare Manager.
 - c. Landscape Industry Certified Lawncare Technician.
 - 5. Pesticide Applicator: State licensed, commercial.
- E. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according for testing indicated.

1.15 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing.

1.16 DELIVERY, STORAGE, AND HANDLING

- A. Deliver packaged products in an undamaged condition in original containers, displaying manufacturer's labels, along with instructions for handling, storing, unpacking, protecting, and installing.
- B. Deliver and store materials in manufacturer's original containers, with seals unbroken and identification labels intact until time of use.
- C. Deliver products to achieve the shortest duration of storage time as practicable.
- D. Deliver all chemical products in original, unopened containers with original labels intact and legible, which state the guaranteed chemical analysis. Store all chemicals in weather protected enclosure.
- E. Comply with manufacturer's written instructions for delivery, storage, and handling, and as required to prevent damage to products and work during construction.
- F. Store products and materials in a neat and orderly manner. Maintain clear aisles and access to work areas. Protect stored products from theft and damage. Store products above ground in weathertight, ventilated packaging or enclosures.
- G. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.
- H. Store liquids in tightly closed containers protected from freezing.
- I. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- J. 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 materials with appropriate certificates.
- K. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.
- L. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

1.17 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of all site elements and other construction contiguous with the work of this section prior to fabrication and/or installation.
- B. The work shall not occur in the presence of standing water, mud, snow, or frozen subgrade conditions. Work shall not occur while precipitation is occurring or during excessive winds, or when temperatures are outside the limits specified in this specification. Work completed during these conditions will be rejected.
- C. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements.
- F. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of final acceptance.
 - 1. Planting: April 1 – July 1 and September 1 - November 1.
- G. 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.

1.18 EXCAVATING AND GRADING AROUND UTILITIES

- A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.
- B. Determine location of underground utilities and perform work in a manner that will avoid damage. Hand excavate as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.
- C. Notification of the utility locate services is required for all Excavation and grading deeper than 12 inches: The Contractor is responsible for knowing the location and avoiding utilities that are not covered by the local utility locator service.

1.19 OBSERVATION OF THE WORK

- A. The Landscape Architect may observe the work at any time. They may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting specifications shall be paid by the Contractor.

- B. The Landscape Architect shall be informed of the progress of the work so the work may be observed during key times in the construction process. The Landscape Architect shall be afforded sufficient time to schedule visits to the site. Failure of the Landscape Architect to make field observations shall not relieve the Contractor from meeting all the requirements of this specification.

1.20 FIRST WORK IN PLACE

- A. The Landscape Architect shall be informed once the first work in place has been completed for all individual elements included in this section for review to ensure the work is proceeding in accordance with the approved samples and mockups and per the Contract Documents. The Landscape Architect shall be afforded sufficient time to schedule visits to the site for review. In the event that sufficient time cannot be provided the Contractor shall provide images from multiple angles and perspectives of the work for Landscape Architect review.

1.21 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering and wear.
 - b. Separation or delamination of materials and components.
 - 2. Warranty Period: **One year** from date of Substantial Completion.

1.22 MAINTENANCE SERVICE

- A. Contractor to provide standard industry maintenance on all scope items herein until Final Acceptance.

PART 2 - PRODUCTS

2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species:
 - 1. Quality: State-certified seed of grass species as listed below for solar exposure.
 - 2. Quality: Seed of grass species as listed below for solar exposure, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:

3. Full Sun: Kentucky bluegrass (*Poa pratensis*), a minimum of three cultivars.
4. Sun and Partial Shade: Proportioned by weight as follows:
 - a. 50 percent Kentucky bluegrass (*Poa pratensis*).
 - b. 30 percent chewings red fescue (*Festuca rubra* variety).
 - c. 10 percent perennial ryegrass (*Lolium perenne*).
 - d. 10 percent redtop (*Agrostis alba*).
5. Shade: Proportioned by weight as follows:
 - a. 50 percent chewings red fescue (*Festuca rubra* variety).
 - b. 35 percent rough bluegrass (*Poa trivialis*).
 - c. 15 percent redtop (*Agrostis alba*).

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 that is strongly rooted and capable of vigorous growth and development when planted.
- B. Turfgrass Species: Sod of grass species as follows, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:
 1. Full Sun: Kentucky bluegrass (*Poa pratensis*), a minimum of three cultivars.
 2. Sun and Partial Shade: Proportioned by weight as follows:
 - a. 50 percent Kentucky bluegrass (*Poa pratensis*).
 - b. 30 percent chewings red fescue (*Festuca rubra* variety).
 - c. 10 percent perennial ryegrass (*Lolium perenne*).
 - d. 10 percent redtop (*Agrostis alba*).
 3. Shade: Proportioned by weight as follows:
 - a. 50 percent chewings red fescue (*Festuca rubra* variety).
 - b. 35 percent rough bluegrass (*Poa trivialis*).
 - c. 15 percent redtop (*Agrostis alba*).

2.3 FERTILIZERS AND MYCORRHIZA

- A. Planting Soil Supplements (For All Lawn and seeded Areas):
 1. Product: Assure 5-5-5 with Mycorrhiza or approved equivalent.
 2. Application Rate: By application type per Manufacturer.
 3. Contact: www.assurefertilize.com.

- 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. (0.45 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.

- 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.

2.4 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

- B. Sphagnum Peat Mulch: Partially decomposed sphagnum peat moss, finely divided or of granular texture, and with a pH range of 3.4 to 4.8.

- C. Muck Peat Mulch: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent, and containing no sand.

- D. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch (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.

- E. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

- F. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

- G. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.5 PESTICIDES

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.6 EROSION-CONTROL MATERIALS

- A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches (150 mm) long.
- B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd. (0.5 kg/sq. m), with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches (150 mm) long.
- C. Erosion-Control Mats: Cellular, nonbiodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of 6-inch (150-mm) nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Prior to installation examine site to confirm that existing conditions are satisfactory for the work of this section to proceed.
- B. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope toward the under drain lines as shown on the drawings.
- C. Confirm that no adverse drainage conditions are present.
- D. Confirm that no conditions are present which are detrimental to plant growth.
- E. Confirm that utility work has been completed per the drawings.
- F. If unsatisfactory conditions are encountered, notify the Landscape Architect immediately to determine corrective action prior to proceeding.

3.2 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - 3. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Landscape Architect and replace with new planting soil.

3.3 PREPARATION

- A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
 - 2. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.4 TURF AREA PREPARATION

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 32 91 13 "Soil Preparation." Coordinate "Placing Planting Soil" Paragraph below with Section 329113 "Soil Preparation" or Section 329115 "Soil Preparation (Performance Specification)."
- B. Placing Planting Soil: Place and mix planting soil in place over exposed subgrade or place manufactured planting soil over exposed subgrade] [Blend planting soil in place.
 - 1. Reduce elevation of planting soil to allow for soil thickness of sod.
- C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- D. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.5 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.

3.6 COORDINATION WITH PROJECT WORK

- A. The Contractor is responsible for investigating, and being aware of, the work requirements of their sub-contractors and other contractors. The Contractor shall coordinate with all other work that may impact the completion of the work herein.
- B. Prior to the start of work, prepare a detailed schedule of the work for coordination with other trades.

3.7 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph (8 km/h).
 - 1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 2. Do not use wet seed or seed that is moldy or otherwise damaged.
 - 3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate of 5 to 8 lb/1000 sq. ft. (2.3 to 3.6 kg/92.9 sq. m).
- C. Rake seed lightly into top 1/8 inch (3 mm) of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets and 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.
- E. Protect seeded areas with erosion-control mats where indicated on Drawings; install and anchor according to manufacturer's written instructions.

- F. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre (42 kg/92.9 sq. m) to form a continuous blanket 1-1/2 inches (38 mm) in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
 - 1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
 - 2. Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gal./1000 sq. ft. (38 to 49 L/92.9 sq. m). Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.
- G. Protect seeded areas from hot, dry weather or drying winds by applying planting soil 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.

3.8 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, slow-release fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
 - 1. Mix slurry with fiber-mulch manufacturer's recommended tackifier.
 - 2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre (15.6-kg/92.9 sq. m) dry weight, and seed component is deposited at not less than the specified seed-sowing rate.
 - 3. Spray-apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre (5.2-kg/92.9 sq. m) dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 lb/acre (10.4 kg/92.9 sq. m).

3.9 SODDING

- A. Lay sod within 24 hours of harvesting unless a suitable preservation method is accepted by Landscape Architect prior to delivery time. 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 soil or sod during installation. Tamp and roll lightly to ensure contact with soil, 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 slopes exceeding 1:3.
 - 2. Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than two anchors per sod strip to prevent slippage.

- 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.

3.10 TURF RENOVATION

- A. Renovate existing turf where indicated.
- B. Renovate turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
 - 1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
 - 2. Install new planting soil as required.
- C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.
- D. Remove topsoil containing foreign materials, such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.
- E. Mow, dethatch, core aerate, and rake existing turf.
- F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
- G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.
- H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches (150 mm).
- I. Apply soil amendments and initial fertilizer required for establishing new turf and mix thoroughly into top 4 inches (100 mm) of existing soil. Install new planting soil to fill low spots and meet finish grades.
 - 1. Soil Amendment(s): according to requirements of Section 32 91 13 "Soil Preparation."
 - 2. Initial Fertilizer: Slow-release fertilizer applied according to manufacturer's recommendations.
- J. Apply seed and protect with straw mulch or sod as required for new turf.
- K. Water newly planted areas and keep moist until new turf is established.

3.11 TURF MAINTENANCE

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll,

regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches (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 one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Mow Kentucky bluegrass, buffalograss, annual ryegrass, chewings red fescue to a height of 1-1/2 to 2 inches (38 to 50 mm).

D. Turf Postfertilization: Apply slow-release fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) to turf area.

3.12 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Landscape 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.

3.13 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.14 GRADE AND ELEVATION CONTROL

- A. Provide grade and elevation control during installation of the work of this section. Utilize grade stakes, surveying equipment, and other means and methods to assure that grades and contours conform to the grades indicated on the plans.

3.15 INSTALLATION TOLERANCES

- A. Final soil, sod/seed installation after planting should be within 1/2 inch of grades shown on the grading plan.

3.16 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

3.17 REPAIR AND REPLACEMENT

- A. General: Repair or replace that is damaged by construction operations, in a manner approved by Landscape Architect.

3.18 WASTE HANDLING

- A. General: Handle waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

3.19 CLEANING

- A. The contractor should clean the job site and remove any excess materials. Coordinate with Owner for storage locations for any Attic Stock materials where applicable.

3.20 PROTECTION

- A. Contractor shall furnish and install construction fence around new installations to prevent access. Fencing shall be maintained in place for a minimum of 48 hours after completion of

installation, or as directed by the Landscape Architect. Drying period may take longer due to weather conditions.

- B. Contractor shall notify Landscape Architect that landscape irrigation shall be restricted near installations until applicable drying period is complete. Standing water on installations shall be restricted at all times.

3.21 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.
- C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- D. Remove nondegradable erosion-control measures after grass establishment period.

3.22 MAINTENANCE SERVICE

- A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. 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: until final acceptance.
 - 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: until final acceptance.
 - 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.

3.23 DEMONSTRATION AND TRAINING

- A. Engage a manufacturer-authorized service representative and/or other authorized professional to train Owner's maintenance personnel to adjust and operate all components herein.
- B. Train Owner's maintenance personnel in proper maintenance procedures for all components herein.

City of Evanston
Evanston Animal Shelter
Holabird & Root, LLC Project No. 16015

Issue for Bid / Permit
12/08/2022

END OF SECTION 32 92 00

SECTION 32 93 00 - 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. Tree stabilization.
- 3. Tree-watering devices.

- B. Related Requirements:

- 1. Section 32 84 00 "Planting Irrigation" for related irrigation systems.
- 2. Section 32 91 13 "Soil Preparation" for related soil profiles.
- 3. Section 32 92 00 "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.
- 4. Section 33 46 00 "Subdrainage" for related drainage systems.

1.3 PERMITS AND FEES

- A. Permits: The Contractor shall secure and pay for all permits, inspections, and certificates of inspection of any governmental and inspection body having jurisdiction over all or any part of the work included under this section and/or such inspections etc., required by these specifications.
- B. Fees: The Contractor shall secure and pay for all fees and assessments in connection with the work under this contract and shall include this cost in its bid and contract price.

1.4 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

- C. 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. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than the minimum root spread according to ANSI Z60.1 for type and size of plant required.
- E. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
- F. 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.
- G. Finish Grade: Elevation of finished surface of planting soil.
- H. Natural Disaster: The term "Natural Disaster" shall be defined as any event that is unpredictable and uncontrollable by the Landscape Architect, Owner, or Contractor. Any predictable and preventable event made known to the Contractor prior to installation shall not be defined as a Natural Disaster.
- I. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.
- J. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- K. Planting Area: Areas to be planted.
- L. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 32 91 13 "Soil Preparation" for drawing designations for planting soils.
- M. 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.
- N. 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.
- O. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

- P. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- Q. Supplemental Planting Aids: Any and all supportive measures employed to ensure that installed plant material meets the requirements outlined in this specification at the end of the guarantee period.

1.5 PRE-INSTALLATION MEETINGS

- A. Pre-installation Meeting: Conduct meeting at Project Site, Manufacturer's Facility of Fabricator's Shop. Confirm with Owner and Landscape Architect 14 days prior to conference.
 - 1. Before submitting submittals, review submittals, mockup and other requirements of this section and examine procedures for ensuring quality of the scope herein. Require representatives of each entity directly concerned with the scope herein, including but not limited to, the following:
 - a. Contractor's superintendent.
 - b. Subcontractor.
 - c. Special Subcontractor.
 - d. Product manufacturer and/or local representative.
 - e. Landscape Architect.
 - 2. Review methods and procedures related to the work of this section, including but not limited to, the following:
 - a. Responsibilities of each party.
 - b. Coordination of Landscape Architect's review of the work, including but not limited to:
 - 1) Site or Shop Visits to Review Samples and Mockups
 - 2) Site Visits to Observe General Construction Progress
 - 3) Site or Shop Visits to Review Fabrication Progress
 - 4) Site Visits to Review First Work In Place
 - 5) Site Visits for Punch List Review
 - 6) Site Visits for Punch List Completion Review
 - 7) Site Visit for Warranty Review
 - c. Lines of authority and communication for the project. Procedures for resolution of any project document ambiguity.
 - d. Methods for documenting, reporting, and distributing documents and reports.
 - e. Proposed sources of materials.
 - f. Procedures for packaging and storing archive samples.
 - g. Review of the time schedule for all installation and testing. Schedule of workdays and/or starting times if third party testing verification is required.
 - h. Quality control.
 - i. Temperature and weather limitations. Installation procedures for adverse weather conditions. Defining acceptable subgrade or ambient moisture and temperature conditions for working during installation.
 - j. Subgrade conditions, dewatering responsibilities, and subgrade maintenance plan.
 - k. Deployment techniques including allowable subgrade conditions.
 - l. Construction, material placement, and backfilling.

- m. Requirements for protecting work, including restriction of traffic and adjacent work impacting during installation period and for remainder of construction period.
- n. Measurement and payment schedules.
- o. Health and safety.
- p. Procedures and responsibilities for preparation and submission of as-built drawings.

1.6 COORDINATION

- A. Refer to Division 1 Requirements.
- B. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
 - 1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.7 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Manufacturer's Product Literature and Specification Data.
 - 2. Manufacturer's written instructions for recommended maintenance practices.
 - 3. Color and finish samples for verification and selection.
 - 4. Written manufacturer's warranty.
 - 5. Product liability insurance certificate with project owner as certificate holder.
 - 6. MSDS for items in Part 2 "Products."
 - 7. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
 - 8. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Contractor to provide photographs of both individual plants and the block of plants if species quantity is more than one (1) of the same size. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph in addition to a human figure. Where applicable also provide an image of each species and size showing root mass. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.
 - 9. Tree Tagging: Contractor or nursery shall locate all trees and tag them with unique seal numbers. Contractor is to photograph each individual tree and provide each image with the seal number, variety, size, and nursery location labeled on the image. Landscape Architect shall review the images and approve prior to visiting the nursery to approve the trees and place the unique seal of the Landscape Architect on each tree. No trees shall be accepted unless they have a unique seal from the contractor or landscape architect. The contractor is to schedule tagging trips to the various nurseries in coordination with the Landscape Architect.

10. Tagging Log: Contractor shall keep a log detailing information for each tagged tree. Such information shall include the source nursery where the material is tagged, location within nursery, size of trees, tag or seal numbers, colors of flagging tape (if applicable), canopy height, spread, and branching height. Provide submittal before beginning construction.
- B. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.
- C. Samples for Verification: For each of the following:
 1. Mulch: 1-quart (1-L) 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. Weed Control Barrier: 12 by 12 inches (300 by 300 mm).
 3. Root Barrier: Width of panel by 12 inches (300 mm).
- D. Shop Drawings: Prepared by or under the supervision of a qualified professional, detailing fabrication and assembly.
 1. Submit shop drawings within a reasonable time so as not to delay the start of material fabrication and installation.
 2. Submit shop drawings per above allowing a minimum review time of 10 business days for review and response. Per above, also allow enough time for revisions and resubmittal where reasonably predictable.
 3. Shop drawings shall show the proposed layout identifying all components and details based on field verified conditions and measurements.

1.8 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- B. 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.
- C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.
- D. Sample Warranty: For special warranty.
- E. Percolation Test: After the Contractor has performed percolation tests (as outlined in Part 3 – Execution, 3.1 Site Examination, C. Percolation Test), the Contractor shall submit a log of the

percolation rates, with a plan outlining the locations of each test pit before planting trees. Provide submittal before beginning construction.

- F. Site Visit Record: After each site visit during the guarantee period, the Contractor shall submit a written record of the visit, including any problems, potential problems, and any recommended corrective action.
- G. Preconstruction test reports.
- H. Source quality-control test reports.
- A. Field quality-control and special inspection reports.
- B. Minutes of pre-installation conference.
- C. Maintenance Instructions.
- D. Warranty: Written manufacturer's warranty.

1.9 CLOSEOUT SUBMITTALS

- A. Maintenance Data: From Installer including a recommended maintenance plan with procedures for inspection and care during a calendar year. Submit before start of required warranty and maintenance periods

1.10 MAINTENANCE MATERIAL SUBMITTALS

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

1.11 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Authorities Having Jurisdiction for all work included in this section.
- B. Codes and Standards: Conform work to all applicable codes and standards.
- C. Manufacturer Qualifications: Provide manufacturer qualifications as follows:
 - 1. Submit a list of ten completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.
 - 2. Submit qualifications of manufacturer.
 - 3. Submit manufacturer's quality control program.
 - 4. Submit example of Material Warranty and any other applicable warranties.

- D. 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 Section 01 40 00 "Quality Requirements."
 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
 - a. Landscape Industry Certified Technician - Exterior.
 - b. Landscape Industry Certified Interior.
 - c. Landscape Industry Certified Horticultural Technician.
 5. Pesticide Applicator: State licensed, commercial.
- E. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
1. Selection of plants purchased under allowances is made by Landscape Architect, who tags plants at their place of growth before they are prepared for transplanting.
- F. 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.
 2. Other Plants: Measure with stems, petioles, and foliage in their normal position.
- G. Plant Material Observation: Landscape Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Landscape Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
1. Notify Landscape Architect of sources of planting materials seven days in advance of delivery to site.
- H. Guarantee:
1. Plants shall be healthy, free of pests and disease, and in flourishing conditions at the end of the guarantee period. Plants shall be free of dead and dying branches and branch tips, and shall bear foliage of normal density, size, and color for the species.

2. Plants shall be guaranteed for a period of one (1) year after the date of acceptance as described in the General Conditions. When the work is accepted in parts, the guarantee periods shall extend from each of the partial acceptances to the terminal date of the last guarantee period. Thus, all guarantee periods terminate at one time.
3. Plants that are dead or not in a vigorous, thriving condition, as determined by the Landscape Architect during and at the end of the guarantee period, shall be deemed unacceptable. The Contractor is to replace unacceptable material without cost to the Owner, as soon as weather conditions permit and within the specified planting period, all plants determined by the landscape architect to be dead or in an unacceptable condition during and at the end of the guarantee period. To be considered acceptable, plants shall be free of dead or dying branches and branch tips and shall bear foliage of normal density, size and color. Replacements shall closely match adjacent specimens of the same species. Replacements shall be subject to all requirements stated in this specification.
4. The Contractor is responsible for the condition and quality of work and materials during construction, and until Acceptance. Contractor shall bear the total cost of replacing any and all plant material until this time. Supplemental Planting Aids shall be used at the discretion of the Contractor to ensure the performance of this specification. The Contractor is responsible for the work whether Planting Aids were used or not.
5. The Contractor is exempt from replacing plants, after acceptance and during the guarantee period, that are removed by others, lost or damaged due to occupancy of the project in any part, lost or damaged by a third party, vandalism, or any natural disaster.
6. Replacements shall closely match adjacent specimens of the same species. Replacements shall be subject to all requirements stated in this Specification. Make all necessary repairs due to plant replacements. Such repairs shall be done at no extra cost to the Owner
7. The guarantee of all replacement plants shall extend for an additional one-year period from the date of their acceptance after replacement. In the event that a replacement plant is not acceptable during or at the end of the said extended guarantee period, the Owner may elect one more replacement item or a credit for each item. These replacement items are not protected under a guarantee period.
8. At the end of the guarantee period, and no less than five days prior to the final inspection, tree wrap, ties, and guying shall be removed from the site. Tree wraps should not be on trunks during active growing seasons. All trees that have leaned or fallen over shall be straightened. The guarantee period for any leaned or fallen trees will be extended by one year after being straightened. Final Acceptance will be given only when all the requirements of the section have been met.

I. Selection of Plant Material:

1. Submit to the Landscape Architect the names and locations of nurseries proposed as sources of acceptable plant material. Inspect all nursery materials to determine that the materials meet the requirements of this section. Prior to viewing by the Landscape Architect, the Landscape Contractor shall pre-tag proposed materials at the nurseries, photograph the material (full tree in each image with a person and measuring stick for scale), and submit photographs to landscape architect for initial review.
2. Based on photographs, tagging by the Landscape Architect may not be needed at Landscape Architect's discretion.
3. Based on Landscape Architect discretion, contractor shall schedule with the Landscape Architect trips for viewing plant materials at nurseries. These trips to the nurseries shall

be efficiently arranged to allow the Landscape Architect to maximize viewing time. A minimum of six weeks shall be allowed for this viewing prior to the time that the plants are to be dug.

4. Label each tree with a securely attached waterproof tag bearing legible designation of botanical and common name. Identification of plant name shall be listed in "Hortus Third". Place the label in the north side of each tree in the nursery prior to digging.
5. The Landscape Architect shall attach their seal to each tree. Viewing and/or sealing of plant materials by the Landscape Architect at the nursery does not preclude the Landscape Architect's right to reject plant material while on site.
6. The Landscape Architect will also ribbon or mark the tree in a specific way as to guide the Contractor to properly face the tree in its planted location. This does not preclude the Landscape Architect from adjusting the facing of any tree upon review on site.
7. When plant material is sourced from wholesale distribution nurseries, it is the responsibility of the Landscape Contractor to make the material available for viewing by the Landscape Architect. The Landscape Contractor shall provide alternate nursery options if such material is deemed unacceptable. Photographs are an acceptable means of viewing plant material in this instance.
8. Where requested by the Landscape Architect, photographs of plant materials or representative samples of plants shall be submitted. Photographs shall be legible and clearly depict the plant specimen. Each submitted image shall contain a height reference, such as a measuring stick. The approval of plant materials by the Landscape Architect via photograph does not preclude the Landscape Architect's right to reject material while on site.

J. Product Substitutions:

1. Products proposed for substitution shall be submitted to the Landscape Architect for approval. Only Approved substitutions for specified products shall be acceptable.
2. Contractor and Manufacturer of substitute material shall submit written guarantee that substitute product(s) matches specified product in every way.
3. The contractor shall be held solely and completely liable for any construction failure resulting from the use of materials unspecified or unapproved by the Landscape Architect.
4. The contractor shall be held solely and completely liable for any construction failure resulting from the use of materials approved by the Client or Owner, without the knowledge of the Architect and/or Landscape Architect.
- 5.

K. Unavailability of Plant Material:

1. Substitutions must be approved by the Landscape Architect.
2. In the event that the Landscape Contractor cannot find the specified plant material, the Landscape Architect may require that the Landscape Contractor find the plant material using a plant broker.
3. The Contractor shall be held solely and completely liable for any failure resulting from the use of plant materials unspecified or unapproved by the Landscape Architect. At the Landscape Architect's discretion, the Contractor may be asked to remove unspecified or unapproved plant material and replace with Landscape Architect approved plant material.

L. Rejection of Plant Material:

1. The Landscape Architect has the right to reject any and all plant material that does not conform to the requirements of this specification.
2. Evidence of damage to plant material, which destroys the natural character of the plant, shall be cause for rejection.
3. When a plant has been rejected, remove it from the area of the work and replace it with one of the required size and quality. Replacement plant material shall be approved by Landscape Architect, as documented in Part 1-General, 1.4 Quality Assurance, B. Selection of Plant Material. The Contractor shall bear the total cost of replacing rejected plant material.
4. Any plant that has the following characteristics shall be cause for rejection:
 - a. Any tree that has a canopy with 50% or more dead limbs.
 - b. Any tree that has dead limbs that, when removed, will result in the loss of 30% or more of the structure and form of the canopy of the tree.
 - c. Any tree that is of a species that characteristically has a dominant central leader, and if the leader is dead, when removed the tree will not have a form consistent with the species.
 - d. Any tree that has open wounds (not completely healed over) that penetrates the bark to the wood on trunks or major limbs the removal of which would result in the loss of 30% or more of the structure and form of the tree.

M. Supplemental Planting Aids:

1. General: Supplemental planting aids, as approved by the Landscape Architect, shall be used at the discretion of the Contractor to ensure that plantings meet the requirements at the end of the guarantee period. The Contractor is responsible for the condition of the plant material, whether planting aids are used or not. Use of supplemental planting aids will be incorporated as part of the Contractors bid, and their use will not incur an additional cost to the Owner.
2. Anti-Desiccant: Anti-Desiccant shall be applied to ensure transported trees and shrubs are not affected by damaging winds during transit. Anti-Desiccant may also be applied to ensure the survival of newly planted trees and shrubs through the winter.
3. Tree Staking and Guying: Tree guying shall be provided wherever shown on the landscape plans. In addition to the trees shown on the plan, additional trees may be guyed as deemed necessary by the Contractor and approved by the Landscape Architect. Additional trees to be guyed shall not be an additional cost to the Owner but shall be included within the Contractor's original proposal. The Landscape Contractor is responsible for the tree's condition under the warranty regardless of whether the tree was guyed. It is the Contractor's responsibility to replace or repair trees which settle or blow over.
4. Fertilizer: Fertilizer and Microrhizome Stimulant shall be provided at the discretion of the Contractor to ensure the plant material is healthy and vigorous at the end of the guarantee period. This is in addition to any Fertilizer or Microrhizome Stimulant required by this specification.

N. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified for testing indicated. Provide sting agency qualification as follows:

1. Submit a list of ten completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.

2. Submit resumes and/or qualifications of testing manager(s).
3. Submit testing quality control program.
4. Submit example of Material Warranty and any other applicable warranties.

O. Mockups: Provide mockup for each type of component per the Drawings and/or shop drawing.

1. Build mockups of full-profile sections to demonstrate including but not limited to overall material quality, typical joints; typical transitions, surface finish, surface texture, color; and standard of workmanship.
2. Build mockups in the location and of the size indicated. Build mockups where directed by Landscape Architect.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Landscape Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may not become part of the completed work.
5. Mockups to be retained on site or at approved location by Owner and Landscape Architect until all related work scope is deemed Substantially Complete.
6. Contractor to rework mockups as necessary until mockups are accepted.

1.12 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing.

1.13 DELIVERY, STORAGE, AND HANDLING

- A. Deliver packaged products in an undamaged condition in original containers, displaying manufacturer's labels, along with instructions for handling, storing, unpacking, protecting, and installing.
- B. Deliver and store materials in manufacturer's original containers, with seals unbroken and identification labels intact until time of use.
- C. Deliver products to achieve the shortest duration of storage time as practicable.
- D. Deliver all chemical products in original, unopened containers with original labels intact and legible, which state the guaranteed chemical analysis. Store all chemicals in weather protected enclosure.
- E. Comply with manufacturer's written instructions for delivery, storage, and handling, and as required to prevent damage to products and work during construction.
- F. Store products and materials in a neat and orderly manner. Maintain clear aisles and access to work areas. Protect stored products from theft and damage. Store products above ground in weathertight, ventilated packaging or enclosures.

- G. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.
- H. Store liquids in tightly closed containers protected from freezing.
- I. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- J. 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 materials with appropriate certificates.
- K. Deliver bare-root stock plants within 36 hours of digging. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting. Transport in covered, temperature-controlled vehicles, and keep plants cool and protected from sun and wind at all times.
- L. 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.
- M. If deciduous trees are moved when in full-leaf, spray with an approved anti-desiccant per manufacturer's recommendations at nursery no greater than 48 hours prior to digging, and again 2 weeks after transplanting. Spraying should take place in early morning hours with foliage at maximum turgidity. It is the responsibility and option of the Contractor to decide if anti-desiccant shall be applied to the tree before delivery.
- N. Evidence of improper digging, inadequate protection following digging, carelessness while in transit, evidence of desiccation or wind-related damage, or improper handling or storage, shall be cause of rejection.
- O. Do not drop balled and burlapped stock during delivery or handling. Evidence of cracked or damaged rootball shall be cause for rejection. Should the roots be dried out, large branches be broken, ball of earth broken, loosened, or undersized, or areas of bark be torn, the Landscape Architect will reject the injured plant.
- P. Handle planting stock by root ball.
- Q. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F (16 to 18 deg C) until planting.

- R. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
 - 1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.
- S. 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.
- T. 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. Heel-in bare-root stock. Soak roots that are in less than moist condition in water for two hours. Reject plants with dry roots.
 - 2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
 - 3. Do not remove container-grown stock from containers before time of planting.
 - 4. 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.
 - 5. Set trees and plants in shade, protect from weather and mechanical damage, and keep roots moist by covering with mulch, burlap or other means acceptable to the Landscape Architect for retaining moisture.
 - 6. The duration, method and location of storage of plant materials shall be subject to the approval of the Landscape Architect.
 - 7. Provide proper spacing for trees, such that the stockpiled plant material has full access to light and air. Take all precautions to prevent defoliation of stockpiled material.
 - 8. Plant material subject to improper storage procedures shall be rejected.
 - 9. Contractor shall determine if there is sufficient space available to properly stockpile plant material at the time of bidding.
- U. Do not remove container-grown stock from containers until planting time. Plant container-grown stock immediately once removed from container.

1.14 FIELD CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.
- B. The work shall not occur in the presence of standing water, mud, snow, or frozen subgrade conditions. Work shall not occur while precipitation is occurring or during excessive winds, or when temperatures are outside the limits specified in this specification. Work completed during these conditions will be rejected.

- C. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements.
- F. 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: see 3.3, this Section.
 - 2. Fall Planting: see 3.3, this Section.
- G. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

1.15 EXCAVATING AND GRADING AROUND UTILITIES

- A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.
- B. Determine location of underground utilities and perform work in a manner that will avoid damage. Hand excavate as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.
- C. Notification of the utility locate services is required for all Excavation and grading deeper than 12 inches: The Contractor is responsible for knowing the location and avoiding utilities that are not covered by the local utility locator service.

1.16 OBSERVATION OF THE WORK

- A. The Landscape Architect may observe the work at any time. They may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting specifications shall be paid by the Contractor.
- B. The Landscape Architect shall be informed of the progress of the work so the work may be observed during key times in the construction process. The Landscape Architect shall be afforded sufficient time to schedule visits to the site. Failure of the Landscape Architect to make field observations shall not relieve the Contractor from meeting all the requirements of this specification.

1.17 FIRST WORK IN PLACE

- A. The Landscape Architect shall be informed once the first work in place has been completed for all individual elements included in this section for review to ensure the work is proceeding in accordance with the approved samples and mockups and per the Contract Documents. The Landscape Architect shall be afforded sufficient time to schedule visits to the site for review. In the event that sufficient time cannot be provided the Contractor shall provide images from multiple angles and perspectives of the work for Landscape Architect review.

1.18 PLANT LAYOUTS

- A. Contractor to stake all trees and flag all shrub locations for review and approval by Landscape Architect prior to planting. Provide Landscape Architect with a minimum of 5 business days notice prior to review.
- B. Contractor to set all trees and shrubs on top of finished grade per approved staked and flagged locations for facing and final approval by Landscape Architect prior to planting. Provide Landscape Architect with a minimum of 5 business days notice prior to review.
- C. For all grasses, perennials, groundcover and annuals, set out plant material on top of proposed grade for Landscape Architect review prior to planting in accordance with planting plans and details. Provide Landscape Architect with a minimum of 5 business days notice prior to review.
- D. For all bulbs, Landscape Architect to paint out locations per plan or modify locations from plan and/or directly layout bulbs in the field. Provide Landscape Architect with a minimum of 5 business days notice prior to review.
- E. Landscape Architect reserves the right to modify the facing and locations of plantings as needed until plants are installed. Once planted, and if planted locations vary from those approved, Contractor to replant as necessary as directed by Landscape Architect.

1.19 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
 - b. Structural failures including plantings falling or blowing over.
 - c. Faulty performance of tree stabilization, edgings and tree grates.
 - 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: 12 months.
 - b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.
 - c. Annuals: Three months.
 - 3. Include the following remedial actions as a minimum:

- a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
- b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
- c. A limit of one replacement of each plant is 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.

1.20 MAINTENANCE SERVICE

- A. Contractor to provide standard industry maintenance on all scope items herein until Final Acceptance.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
 1. Trees with damaged, crooked, or multiple leaders; 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 are unacceptable.
 2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
- 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 Landscape Architect, with a proportionate increase in size of roots or balls.
- C. Plants shall have outstanding form; symmetrical, heavily-branched with an even branch distribution, densely foliated and/or budded, and a strong, straight distinct leader where this is characteristic of the species. Plants shall possess a normal balance for the species between height and spread. The Landscape Architect shall be the final arbiter of acceptability of plant form.
- D. Provide healthy, vigorous stock, grown in a recognized nursery in accordance with good horticultural practice and free of disease, insects, eggs, larvae, and defects such as knots, scrapes, broken or split branches, fresh limb cuts, sunscald, injuries, abrasions, or disfigurement. All graft unions shall be completely healed, free of extreme succulence.

- E. All trees and shrubs shall be dug prior to leafing out (bud break) in the spring or when plants have gone dormant in the fall except for the following species, which are only to be dug prior to leafing out in the Spring:
1. Alnus species
 2. Betula species
 3. Carpinus species
 4. Celtis species
 5. Cercidiphyllum species
 6. Cornus species
 7. Crataegus species
 8. Fagus species
 9. Halesia species
 10. Ilex opaca species
 11. Koelreuteria paniculata
 12. Larix species
 13. Liquidambar species
 14. Liriodendron species
 15. Malus – in leaf
 16. Nyssa sylvatica
 17. Ostrya virginiana
 18. Populus species
 19. Prunus – all stone fruits
 20. Pyrus species
 21. Quercus—all oaks except Q. palustris
 22. Salix – weeping varieties
 23. Syringa reticulata
 24. Taxodium distichum
 25. Tilia tomentosa varieties
 26. Ulmus species
 27. Viburnum lentago
 28. Zelkova species

Where project schedule does not permit digging at the appropriate time the contractor shall be responsible for sourcing above-ground material. Above-ground material shall be subject to the same standards for quality and warranty.

- F. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
- G. Labeling: Label each 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.
- H. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.
- I. Annuals and Biennials: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm

ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery and that are in bud but not yet in bloom.

2.2 FERTILIZERS AND MYCORRHIZA

- A. Planting Soil Supplements (For All Trees, Shrubs, Perennials, Groundcovers, Vines and Annual Bedding Plants):
1. Product: Assure 5-5-5 with Mycorrhiza or approved equivalent.
 2. Application Rate: By application type per Manufacturer.
 3. Contact: www.assurefertilize.com.

2.3 MULCHES

- A. Organic Mulch For Trees and Shrubs: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of the following:
1. Type: 100 % Screened Double-Processed Hardwood Bark Mulch.
 2. Size Range: varies.
 3. Color: Natural.
 4. Installation Depth:
 - a. Tree and Shrubs: 3 inches
- B. Organic Mulch For Grasses, Perennials and Groundcovers: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of the following:
1. Type: A blend of 50% Screened Double Processed Hardwood Bark Fines and 50% Pine Bark Fines.
 2. Size Range: Screened to 3/8 inches for both Bark Fines.
 3. Color: Natural.
 4. Installation Depth:
 - a. Ornamental Grasses: 2 inches
 - b. Perennials: 2 inches
 - c. Groundcover: 2 Inches
- C. Mineral Mulch: A. Mineral Mulch: Hard, durable stone, washed free of loam, sand, clay, and other foreign sub-stances, of following type, size range, and color:
1. Type: Granite Aggregate Chips
 2. Size: 3/16" or less
 3. Installation Depth:
 - a. Landscape Areas: 2 inches

2.4 WEED-CONTROL BARRIERS

- A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. (101g/sq. m) minimum, composed of fibers formed into a stable network so that fibers retain

their relative position. Fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.

- B. Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, 4.8 oz./sq. yd. (162 g/sq. m).

2.5 PESTICIDES

- A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.6 TREE-STABILIZATION MATERIALS

A. At-Grade Root-Ball Stabilization Materials:

- 1. Proprietary Root-Ball Stabilization Devices: Proprietary at- or below-grade stabilization systems to secure each new planting by root ball and that do not encircle the trunk; sized according to manufacturer's written recommendations unless otherwise indicated.
 - a. Manufacturer: Platipus Earth Anchoring Systems
 - b. Product: Platipus Deadman System – Plati-Mat
 - 1) Wood Deadmen: Timbers measuring 8 inches (200 mm) x 8 inches (200 mm) and 48 inches (1200 mm) long, treated with specified wood pressure-preservative treatment.

B. On-Structure Root-Ball Stabilization Materials:

- 1. Proprietary Root-Ball Stabilization Devices: Proprietary at- or below-grade stabilization systems to secure each new planting by root ball and that do not encircle the trunk; sized according to manufacturer's written recommendations unless otherwise indicated.
 - a. Manufacturer: Platipus Earth Anchoring Systems
 - b. Product: Platipus D-MAN System – Plati-Mat
 - 1) For every 2” of tree caliper provide 3x D-MAN module per Manufacturer recommendations.

2.7 TREE-WATERING DEVICES

- A. Slow-Release Watering Device: Standard product manufactured for drip irrigation of plants and emptying its water contents over an extended time period; manufactured from UV-light-stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.
 - 1. Color: green.

2.8 MISCELLANEOUS PRODUCTS

- A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.
- B. Burlap: Non-synthetic, biodegradable.
- C. Planter Drainage Gravel: Washed, sound crushed stone or gravel complying with ASTM D 448 for Size No. 8.
- D. Planter Filter Fabric: Nonwoven geotextile manufactured for separation applications and made of polypropylene, polyolefin, or polyester fibers or combination of them.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Prior to installation examine site to confirm that existing conditions are satisfactory for the work of this section to proceed.
- B. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope toward the under drain lines as shown on the drawings.
- C. Confirm that no adverse drainage conditions are present.
- D. Confirm that no conditions are present which are detrimental to plant growth.
- E. Confirm that utility work has been completed per the drawings.
- F. If unsatisfactory conditions are encountered, notify the Landscape Architect immediately to determine corrective action prior to proceeding.

3.2 EXAMINATION

- A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
 3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 4. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Landscape Architect and replace with new planting soil.
- C. Examine the surface grade for any circumstances that might be detrimental to plant growth, such as deposits of construction-related waste. Examine the grading, verify all elevations, and notify Landscape Architect in writing of any unsatisfactory conditions.
- D. Examine the sub-grade for evidence of compaction. Examine rubble conditions as to extent shown on Soil Borings, observe the conditions under which work is to be performed, and notify Landscape Architect in writing of any unsatisfactory conditions.
- E. Percolation Test: Contractor is mandated to perform percolation tests to determine the permeability of the sub-grade. For every 5-15 trees and shrubs in a general area, excavate a 12” diameter x 12” deep test pit. Fill each pit with water and allow water to percolate out. Test pits shall be roped off at all times, and filled in when test is complete. If water does not percolate out over a 12 hour period, contact Landscape Architect. Although only one tree percolation test is required for every 15 trees, the Landscape Contractor is still responsible for ensuring that every tree drains properly.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PLANTING SEASON

- A. Planting shall only be performed when weather and soil conditions are suitable for planting the materials specified in accordance with locally accepted practice. Install plant materials during the planting time as described below unless otherwise directed by the Landscape Architect. Planting shall not occur if soil profiles are frozen or if there is a risk of frost. Note exceptions in Part 2.1.A within this section.
1. Evergreen Trees: April 1 – July 1 and September 1 - November 1
 2. Evergreen Shrubs: April 1 – July 1 and September 1 - November 1
 3. Deciduous Trees: April 1 – July 1 and September 1 - November 1
 4. Deciduous Shrubs: April 1 – July 1 and September 1 - November 1
 5. Vines: April 1 – July 1 and September 1 - November 1
 6. Ornamental Grasses: April 1 – July 1 and September 1 - November 1
 7. Perennials: April 1 – July 1 and September 1 - November 1
 8. Groundcover: April 1 – July 1 and September 1 - November 1
 9. Bulbs: October 1 - December 1

3.4 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Landscape Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.
- D. Lay out plants at locations directed by Landscape Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

3.5 PLANTING AREA ESTABLISHMENT

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 32 91 13 "Soil Preparation."
- B. Placing Planting Soil placement according to Section 32 91 13 "Soil Preparation."
- C. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.
- D. Application of Mycorrhizal Fungi: At time directed by Landscape Architect, broadcast dry product uniformly over prepared soil at application rate according to manufacturer's written recommendations.

3.6 COORDINATION WITH PROJECT WORK

- A. The Contractor is responsible for investigating, and being aware of, the work requirements of their sub-consultants and other consultants. The Contractor shall coordinate with all other work that may impact the completion of the work.
- B. Coordinate planting with herbicide application for native seeded areas. Ensure herbicide is inactive prior to installation. Provide a schedule and adjust by RFP (Request for Proposal) as required. 2 weeks should be the amount of time needed for herbicide to become inactive.

3.7 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits.
 - 1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further

- disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
 2. Excavate approximately three times as wide as ball diameter for balled and burlapped, balled and potted, container-grown and fabric bag-grown stock.
 3. Excavate at least 12 inches (300 mm) wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
 4. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
 5. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
 6. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
 7. Maintain supervision of excavations during working hours.
 8. Keep excavations covered or otherwise protected when unattended by Installer's personnel.
 9. If drain tile is indicated on Drawings or required under planting areas, excavate to top of porous backfill over tile.
- B. Backfill Soil: Subsoil and topsoil removed from excavations may not be used as backfill soil unless otherwise indicated.
- C. Obstructions: Notify Landscape 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 Landscape 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.

3.8 PLANTING AROUND UTILITIES

- A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.
- B. Determine location of underground utilities and perform work in a manner that will avoid possible damage. Hand excavate, as required. Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned. Notification of City of Chicago Utilities alert Network (DIGGER) at (312) 744-7000 or Joint Utility Locating Information for Excavators (JULIE) is required for all planting around utilities (800) 892-0123. The Landscape Contractor is responsible for knowing the location and avoiding utilities that are not covered by the above groups.

3.9 PLANTING GENERAL INSTALLATION

- A. Notify Landscape Architect one (1) week prior to layout for approval. Layout trips shall be arranged to maximize Landscape Architects viewing time. Lay out all individual tree and shrub locations. Secure Landscape Architect's acceptance before digging and start of planting work. Make adjustments as required by Landscape Architect. Landscape Architect to confirm facing of each plant in place on site prior to planting and if planted without the approval of the Landscape Architect the Landscape Architect reserves the right to relocate or reface any plant at their discretion.
- B. Contractor shall layout all individual containerized plants in-field for Landscape Architect approval. Landscape Architect to layout scheduled prototype area of each type of planting area. Job foreman is to be involved for layout verification.
- C. Install plants in designed locations according to Planting Plan and approved layout by Landscape Architect in field.
- D. Install or apply manufactured products in accordance with manufacturer's written instructions.
- E. Backfilling: Backfill planting holes with same soil that was removed. Thoroughly water fill material as backfilling proceeds.
 - 1. Provide well-aerated soil that is firm enough to support root balls, but not overpacked.
- F. When applicable, plant trees before adjacent shrubs, groundcovers, vines and other plants are in place. Where spacing dimensions or locations are not clear, notify the Landscape Architect before installation.
- G. Excavate pits, beds, and trenches with vertical sides and with bottom of excavation slightly raised at center to provide proper drainage. When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify Landscape Architect before planting. Dispose of subsoil removed from planting excavations. Do not mix with planting soil or use as backfill.
- H. Scarify hard subsoil around perimeter of undisturbed tree ball pedestal and on top 12" of undisturbed soil to create a transition layer. Do not scarify top of undisturbed soil.
- I. Allow the finished grades to remain 2"-3" higher than the grades on the grading plan to anticipate settlement over the first year. At the end of the planting guarantee period, reset the grades in this area, if required, to the final grades shown on the grading plan.
- J. Set balled and burlapped (B&B) and container stock on layer of undisturbed subgrade, as indicated on the drawings, plumb and in center of pit or trench with top of ball three (3) inches above adjacent finished landscape grades.
- K. When set, brace rootball by tamping backfilled soil around the lower portion of the rootball. Place additional backfill around base and sides of ball in six-inch (6") lifts. Work each lift to settle backfill and eliminate voids and air pockets. When excavation is approximately two-thirds full, water thoroughly before placing remainder of backfill. Ropes or strings on top of ball shall be cut and shall be pulled back. Burlap or cloth wrapping shall be cut and removed.

Plastic, wood containers and root-bags shall be totally removed from ball and planting pit. Remove top third of wire baskets prior to planting.

- L. Repeat watering until no more is absorbed. Water again after placing final layer of backfill.
- M. Remove all nursery plant identification tags and ribbons. Landscape Architect seals are to remain on plants until the end of the guarantee period, or as directed by Landscape Architect. The Contractor shall remove Landscape Architect seals once Final Acceptance has been given by the Owner. The Owner may direct Contractor to retain seals on trees for future reference. Contractor to confirm prior to removal.

3.10 TREE, SHRUB, AND VINE PLANTING

- A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 inches (50 mm) above adjacent finish grades unless otherwise noted or unless root balls are to be placed under sod profiles.
 - 1. Backfill: Planting soil.
 - 2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
 - 3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
 - 4. Place planting soil supplements equally distributed around each planting pit when pit is approximately one-half filled or per Manufacturer's instructions.
 - a. Quantity: Per Manufacturer instructions.
 - 5. Continue backfilling process. Water again after placing and tamping final layer of soil.
- D. Balled and Potted and Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 inches (50 mm) above adjacent finish grades.
 - 1. Backfill: Planting soil.
 - 2. Carefully remove root ball from container without damaging root ball or plant.
 - 3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.

4. Place planting soil supplements equally distributed around each planting pit when pit is approximately one-half filled or per Manufacturer's instructions.
 - a. Quantity: Per Manufacturer instructions.
 5. Continue backfilling process. Water again after placing and tamping final layer of soil.
- E. Fabric Bag-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 inches (50 mm) above adjacent finish grades.
1. Backfill: Planting soil.
 2. Carefully remove root ball from fabric bag without damaging root ball or plant. Do not use planting stock if root ball is cracked or broken before or during planting operation.
 3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
 4. Place planting soil supplements equally distributed around each planting pit when pit is approximately one-half filled or per Manufacturer's instructions.
 - a. Quantity: Per Manufacturer instructions.
 5. Continue backfilling process. Water again after placing and tamping final layer of soil.
- F. Bare-Root Stock: Set and support each plant in center of planting pit or trench with root flare 2 inches (50 mm) above adjacent finish grade.
1. Backfill: Planting soil.
 2. Spread roots without tangling or turning toward surface. Plumb before backfilling, and maintain plumb while working.
 3. Carefully work backfill in layers around roots by hand. Bring roots into close contact with the soil.
 4. 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 planting soil supplements equally distributed around each planting pit when pit is approximately one-half filled or per Manufacturer's instructions.
 - a. Quantity: Per Manufacturer instructions.
 6. Continue backfilling process. Water again after placing and tamping final layer of soil.
- G. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of 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.

3.11 MECHANIZED TREE-SPADE PLANTING

- A. Trees may be planted with an approved mechanized tree spade at the designated locations. Do not use tree spade to move trees larger than the maximum size allowed for a similar field-grown, balled-and-burlapped root-ball diameter according to ANSI Z60.1, or larger than

manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller.

- B. Use the same tree spade to excavate the planting hole as will be used to extract and transport the tree.
- C. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.
- D. Cut exposed roots cleanly during transplanting operations.
- E. Plant trees following procedures in "Tree, Shrub, and Vine Planting" Article.
- F. Where possible, orient the tree in the same direction as in its original location.

3.12 TREE, SHRUB, AND VINE PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape.
- B. Prune, thin, and shape trees, shrubs, and vines as directed by Landscape Architect until final Acceptance.
- C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Landscape Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.
- D. Do not apply pruning paint to wounds.

3.13 TREE STABILIZATION

- A. Root-Ball Stabilization: Install at- or below-grade stabilization system to secure each new planting by the root ball unless otherwise indicated.
 - 1. Proprietary Root-Ball Stabilization Device: Install root-ball stabilization system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

3.14 ORNAMENTAL AND NATIVE GRASS PLANTING

- A. Remove plants from containers by inverting container, taking care not to damage plant material; or by cutting root mass with a knife on 4-sides to a depth of 1/2-inch (12.7-mm) and cut the bottom of root mass in same manner in an 'X' pattern. Loosen up root systems of container-grown plants.
- B. Do not allow root tips to become damaged from exposure to air; keep growing root tips moist and covered. Plant as quickly as possible upon removal from containers.

- C. Do not set plants too high or too low; plant so that plant crowns are just slightly above soil level. Thoroughly water plants upon planting, and maintain through substantial completion.

3.15 PERENNIAL PLANTING

- A. Prepare planting beds for mass plant areas to achieve a slight crown. Loosen planting bed soil to a depth of 4- to 6-inches (101.6- to 152.5-mm).
- B. Remove plants from containers by inverting container, taking care not to damage plant material. Split biodegradable containers. Loosen up root systems of container-grown plants.
- C. Do not allow root tips to become damaged from exposure to air; keep growing root tips moist and covered. Plant as quickly as possible upon removal from containers.
- D. Set plants in prepared beds so that plant crowns are just slightly above planting soil level. Thoroughly water plants upon planting, and maintain through substantial completion.

3.16 GROUND COVER PLANTING

- A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing unless noted otherwise.
- B. Use planting soil for backfill.
- C. Dig holes large enough to allow spreading of roots.
- D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to 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.

3.17 PLANTING AREA MULCHING

- A. Mulch backfilled surfaces of planting areas and other areas indicated.
 - 1. Trees and Treelike Shrubs in Turf Areas: Apply mulch ring with minimum 36-inch (900-mm) radius around trunks or stems. Do not place mulch within 6 inches (150 mm) of trunks or stems. Do not mulch trees scheduled to be placed under sod profile.
 - 2. Mulch in Planting Areas: Apply mulch over whole surface of planting area, and finish 1/2" below level with adjacent finish grades. Do not place mulch within 6 inches (150 mm) of tree and shrub trunks or stems.

- B. In no case shall mulch come in contact with any part of trunk or root flare. There should be a minimum 6" offset from flare to mulch.
- C. Excess mulch shall be removed and disposed of off-site. Contractor shall not over-mulch planting beds with excess mulch.

3.18 EDGING INSTALLATION

- A. Spaded Edge Edging: Separate planting and otherwise mulched areas from turf areas with a 45-degree, 4 inch (100mm) deep, shovel-cut edge.

3.19 INSTALLING SLOW-RELEASE WATERING DEVICE

- A. Provide one device for each tree.
- B. Place device on top of the mulch at base of tree stem and fill with water according to manufacturer's written instructions.

3.20 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents according to 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 Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.
- C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.21 GRADE, ELEVATION AND ALIGNMENT CONTROL

- A. Provide grade and elevation control during installation of the work of this section. Utilize grade stakes, string lines, surveying equipment, and other means and methods to assure that grades and contours conform to the grades indicated on the plans.
- B. Provide alignment control during installation of the work of this section. Utilize stakes, pins, marking techniques, string lines, surveying equipment, and other means and methods to assure that alignments conform to the alignments on the plans.

3.22 INSTALLATION TOLERANCES

- A. All planting elevations to be within 1/4" of plans and details.

- B. All planting horizontal dimensions to be within 1" of plans and details.

3.23 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

3.24 REPAIR AND REPLACEMENT

- A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Landscape Architect.
 - 1. Submit details of proposed pruning and repairs.
 - 2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
 - 3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Landscape Architect.
- B. Remove and replace plants that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Landscape Architect determines are incapable of restoring to normal growth pattern.
 - 1. Provide new plants of same size as those being replaced for each tree.
 - 2. Species of Replacement Trees: Same species being replaced.

3.25 WASTE HANDLING

- A. General: Handle waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

3.26 CLEANING

- A. The contractor should clean the job site and remove any excess materials. Coordinate with Owner for storage locations for any Attic Stock materials where applicable.
- B. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- C. All garbage shall be coordinated with the waste management plan. Do not bury garbage in back-fill.
- D. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.
- E. 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.

3.27 PROTECTION

- A. Contractor shall furnish and install construction fence around new installations to prevent access. Fencing shall be maintained in place for a minimum of 48 hours after completion of installation, or as directed by the Landscape Architect. Drying period may take longer due to weather conditions.
- B. Contractor shall notify Landscape Architect that landscape irrigation shall be restricted near installations until applicable drying period is complete. Standing water on installations shall be restricted at all times.
- C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- D. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.
- E. The Contractor shall protect landscape work and materials from damage due to landscape operation, operations by other Contractors or trespassers. Maintain protection during installation until acceptance. Treat, repair or replace damaged landscape work immediately. Contractor responsible for replacement due to damage during construction Contractor is not responsible for after construction damage by others, except rodent damage where protection is required.
- F. Damage done to plant materials, or any of the work, by the Contractor, or any of their sub-consultants, shall be replaced by the Contractor at no expense to the Owner.

3.28 MAINTENANCE SERVICE

- A. Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
 - 1. Maintenance Period: Twelve months from date of Substantial Completion.
- B. Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
 - 1. Maintenance Period: Twelve months from date of Substantial Completion.

3.29 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or

vertical position, and performing other operations as required to establish healthy, viable plantings.

- B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.30 DEMONSTRATION AND TRAINING

- A. Engage a manufacturer-authorized service representative and/or other authorized professional to train Owner's maintenance personnel to adjust and operate all components herein.
- B. Train Owner's maintenance personnel in proper maintenance procedures for all components herein.

END OF SECTION - 32 93 00

SECTION 33 1013 - WATER SERVICE

PART 1 - GENERAL

1.1 SUMMARY

- A. This item shall include furnishing all labor, materials, tools, and equipment required to install the water service as established by Contractor in continuity to the plans and specifications for the complete systems. The work shall include excavation for water pipes, water service installation, backfilling trenches, and testing and disinfecting of the complete water systems as required.
- B. Ductile or other slip-joint connected pipe is to be made electrically continuous with exothermically welded bonds across joints. Dielectrics are to be installed at street connection.

1.2 REFERENCES

- A. Illinois Plumbing Code, latest edition.

1.3 SUBMITTALS

- A. Product data for each component of water service.
- B. Each individual unit must be pressure tested and guaranteed for service at pressures minimally equal to pressure ratings specified. The Contractor must provide an affidavit that materials furnished comply with this standard.

1.4 QUALITY ASSURANCE

- A. The Work necessary for the installation of new, or modification to existing services, must be performed by a plumber licensed in the State of Illinois and the City of Evanston. This Work will include, but not be limited to, tapping the main; installing corporation cocks; installing piping, fittings, valves and connecting new service to existing services, as specified herein.

PART 2 - PRODUCTS

2.1 K COPPER PIPE, ASTM B88.

2.2 DUCTILE IRON PIPE

- A. Ductile iron pipe must conform to the requirements of AWWA C151 and with the additions or substitutions specified in this Section.

- B. Pipe bells must be designed to provide a watertight joint without leakage and must be capable of withstanding pressures exceeding those that will rupture pipe of this class and thickness without requiring additional jointing material.
- C. Electrical conductivity must be provided at each joint on all push-on and mechanical jointed pipe to facilitate thawing of frozen pipe and building water services. Conductivity is to be accomplished by installing serrated silicon wedges as recommended or supplied by the pipe manufacture. The use of lead tip gaskets will not be allowed.
- D. All pipes must be manufactured so that where a cut is made at any point along the barrel, the cut end will fit properly into a standard mechanical joint bell and be drip tight at hydrostatic test pressure.
- E. Exterior of pipe must be coated with a petroleum asphaltic material in conformance with AWWA C110, Section 10-10. Interior of pipe must be cement lined in accordance with AWWA C104.
- F. Pipe thickness and classes must conform to standards shown in Table A.

TABLE A PIPE THICKNESS AND CLASS

Pipe Size	Nominal Thickness	Wall	Thickness Class
3-inch	0.34-inch		54
4-inch	0.38-inch		55
6-inch	0.40-inch		55
8-inch	0.45-inch		56
10-inch	0.47-inch		56
12-inch	0.49-inch		56

2.2 JOINTS

- A. Lead joints are not to be used under any circumstances.
- B. Pipe joints must be mechanical joint unless otherwise noted on the drawings or specified here.

- C. Restrained joints when specified are to meet the following requirements: Restrained joint pipe with manufactured weldment, field weldments or manufactured locking rings, locking segments and runner retainers and appurtenances conforming to AWWA C110. Acceptable products are Super-Lock Pipe manufactured by Clow Water Systems Company; FlexRing Pipe or Lok-Ring Pipe manufactured by American Ductile Iron Pipe; or TRFLEX manufactured by United States Pipe and Foundry Company.
- D. Mechanical joint pipe with mechanical joint restraint glands. Mechanical joints must conform to AWWA C110. Gaskets must conform to Section 2.4 of this specification.
- E. Mechanical Joint Restraint Glands.
 - a. Provide restraint glands at all mechanical joints.
 - b. Restraint glands must be designed for use with the standardized mechanical joint bell pipe conforming to AWWA C110 and AWWA C153. Restraint is to be incorporated into the design of the gland. Acceptable products for this use are Mega Lugs manufactured by EBAA Iron Works; Uniflange manufactured by Ford Meter Box; or Star Grip manufactured by Star Pipe Products.
 - c. Restraint is to be accomplished by the use of multiple, wedge style restraints. Proper actuation of the wedges is to be ensured with torque limiting twist off nuts.
 - d. Glands 3-Inches through 16-Inches are to be pressure rated at 350-psi.
 - e. The gland body and restraint components are to be made from ductile iron conforming to ASTM A536, 65-45-12. Ductile iron wedges are to be heat-treated within a range of 370 to 470 BHN.
 - f. The joint is to be capable of full deflection during assembly and joint deflection after assembly
 - g. Provide glands with minimum weights and number of wedges as shown in Table B.
 - h. Retainer glands are not acceptable.

TABLE B – MINIMUM WEIGHT & NUMBER OF WEDGES PER RESTRAINED JOINT

Pipe Size	Number of Wedges	Minimum Weight
3-inch	2	6.0 lbs
4-inch	2	7.0 lbs

6-inch	3	11.0 lbs
8-inch	4	14.5 lbs
10-inch	6	23.0 lbs
12-inch	8	28.5 lbs

- F. Flanged joints must conform to the following:

2.3 FITTINGS

- A. Fittings to be furnished and installed as specified or shown on the Drawings must be mechanical joint, ductile iron in accordance with AWWA C110. Laying length of mechanical joint castings must be as shown in AWWA C110. Wall thickness and allowable variation in the thickness of mechanical joint castings must conform to AWWA C110 and have a 250-psi pressure rating.
- B. Compact fittings may not be used.
- C. Plain ends of mechanical joint fittings must be beveled and gauged to properly seat in push-on joint bells.
- D. The fittings must be smooth and free from defects of every nature that would make them unfit for the use that they were intended. Plugging of fittings is not allowed. Repairing of defects by welding will be allowed if such repairs will not adversely affect the serviceability of the fittings or their ability to meet the strength requirements of the referenced AWWA standards.
- E. All castings must be coated inside and outside with a petroleum asphaltic material in conformance with Section 4.3 of AWWA C110. A cement-mortar lining is not required.
- F. Flanged fittings must conform to AWWA C110, and have a 150-pound per square inch pressure rating.

2.4 GASKETS

- A. All gaskets for pipe, fittings and appurtenances must be vulcanized natural or vulcanized synthetic rubber, non-porous, free of foreign materials and visible defects. Recycled rubber may not be used.
- B. When soil conditions do not permit the use of natural or synthetic rubber gaskets, all gaskets for pipe, fittings and appurtenances must be Nitrile (acrylonitrile butadiene), nonporous, free of foreign materials and visible defects.

- C. Gaskets for flanged joints must be of the ring type, 1/16-Inch thick, and meet the requirements of ANSI Standard B16.21. Acceptable manufactures for gaskets type as manufactured by the Crane Company; Garlock Packing Company; or U.S. Rubber Company.
- D. Gaskets must be stored in a cool place and protected from light, heat, oil, or grease until installed. Any gasket showing signs of cracking, weathering, abrasion or other deterioration will be rejected.

2.5 POLYETHYLENE ENCASEMENT

- A. Polyethylene encasement material must be either 8-mil, low density or 4-mil, cross-laminated, high-density polyethylene tubing in accordance with AWWA C105.

2.6 GATE VALVES

- A. All gate valves are to be City of Evanston standard Gate Valves of the size shown on the drawings that are designed, manufactured, tested, and inspected in accordance with AWWA C500, and in accordance with the exceptions noted here. All valves are to be delivered fully assembled. The following characters must be cast in ½-inch letters on the bonnet of each valve:
 - a. Year of Manufacture
 - b. Manufacture's Name
- B. Gate valves must be of mechanical joint type double disk and in the following sizes: 4-Inch, 6-Inch, 8-Inch, 12-Inch, and 16-Inch.
- C. Material used must meet the requirements as to physical and chemical properties, as specified in this Section.
- D. Valves found to contain defects such as blowholes, shrinkage or slag holes, cold shuts, or cracks will be rejected.
- E. The thickness of metal in castings, whose standard thickness is less than 0.8-Inch, must not be more than 0.08-inch less than the standard thickness. The deficiency in thickness of castings, whose standard thickness is 0.8-inch or more, must not exceed 10% of the standard thickness. The above allowable deficiencies in thickness, however, must not extend over more than one-half of the area of the casting.
- F. After being cleaned and tested, every assembled valve and all metallic parts must be coated inside and outside with coal tar pitch varnish. It must produce a smooth and non-tacky coating tough and tenacious when cold and not brittle nor with any tendency to scale off.
- G. The brass castings must comply with ASTM B584, Copper Alloy UNS No. C83600.
- H. The bronze in the valve stem and in the stem nut must be manganese bronze, complying with ASTM B584, Copper Alloy UNS No. C86700. Stem seals are to be double o-rings complying with ASTM D2000 and ASTM 568A.

- I. The gaskets used between the flanges must be fully faced, 1/32-inch thick and made of heavy-duty, asbestos-free, fiber composition, suitable for water service.
 - J. Bolts and nuts must be made of cast iron or steel. Heads of seal plate bolts must conform to the dimensions shown on the Drawings (an alternate of hex or square head bolt is acceptable) while all other requirements of seal plate bolts must conform to Federal Specification FF-B-575C and nuts must conform to FF-N-836E. Heads of bolts must be unfinished and nuts must be semi-finished. Both bolts and nuts must be hot dipped galvanized as specified in the applicable Federal Specification.
 - K. The valves herein specified must be furnished complete with mechanical joint accessories. The mechanical joint accessories must consist of mechanical joint thrust restraint glands, rubber gaskets, and tee head bolts and hex nuts, all conforming to AWWA C110. Dimensions and tolerances for mechanical joints must conform to table 1 of AWWA C110.
 - L. It will be the manufacturer's responsibility to provide the patterns and gauges necessary to perform the work to be done hereunder. The Department will not furnish these items.
 - M. All valves must open by turning the operating stem clockwise.
 - N. Operating nuts must be 2 ½-Inches square at the base of the nut.
- 2.7 TAPPING VALVES (If Required)
- A. Tapping valves must be Clow or Mueller resilient wedge type tapping valves. Valve must open by turning the operating stem clockwise. Tapping valves must be approved for use by the City of Evanston.
- 2.8 TAPPING SLEEVES (if Required)
- A. All tapping sleeves shall conform to City of Evanston requirements. The tapping connection must be split sleeve, all stainless steel, full gasket type featuring low profile lugs with separate, replaceable bolts for assembly. The sleeve sections must be connected with nuts and bolts, and must be designed to fit ductile iron pipe of the sizes as determined by field inspection. The inside diameter of the branch connection must be of full size so as to allow the free passage of a standard cutter.
 - B. The branch outlet of the sleeve must be either CF8 stainless steel per ASTM A351, type 304 stainless steel per ASTM A240, 125-pounds drilling per ANSI B16.1, recessed for tapping valve per MSS-SP60, bonded flanged gasket.
 - C. All bolts must be type 304 Stainless steel. Bolts must be separate, self aligning, and replaceable. Nuts must be impregnated with anti glaring lubricant.
 - D. The side flange gaskets for bolted sleeves to be furnished with connection must be made of vulcanized natural or synthetic rubber.

- E. The body of each connection must be stenciled with a range of pipe diameters that the connection will fit and also the diameter of the branch.
- F. All sleeves must be designed for 150-pounds per square inch pressure rating.

PART 3 - EXECUTION

3.1 HORIZONTAL SEPARATION - WATER MAINS AND SEWERS

- A. Water mains shall be located at least ten feet horizontally from any existing or proposed drain, storm sewer, sanitary sewer, combined sewer or sewer service connection.
- B. Water mains may be located closer than ten feet to a sewer line when:
 - a. Local conditions prevent a lateral separation of ten feet; and
 - b. The water main invert is at least 18 inches above the crown of the sewer; and
 - c. The water main is either in a separate trench or in the same trench on an undisturbed earth shelf located to one side of the sewer.
- C. When it is impossible to meet (a) or (b) above, both the water main and drain or sewer shall be constructed of slip-on mechanical joint cast or ductile iron pipe. The drain or sewer shall be pressure tested to the maximum expected surcharge head before backfilling.

3.2 VERTICAL SEPARATION - WATER MAINS AND SEWERS

- A. A water main shall be separated from a sewer so that its invert is a minimum of 18 inches above the crown of the drain or sewer whenever water mains cross storm sewers, vertical separation shall be maintained for that portion of the water main located within ten feet horizontally of any sewer or drain crossed. A length of water main pipe shall be centered over the sewer to be crossed with joints equidistant from the sewer or drain.
- B. Both the water main and sewer shall be constructed of slip-on or mechanical joint cast or ductile iron pipe, prestressed concrete pipe, when:
 - a. It is impossible to obtain the proper vertical separation as described in (A) above; or
 - b. The water main passes under a sewer or drain.
- C. A vertical separation of 18 inches between the invert of the sewer or drain and the crown of the water main shall be maintained where a water main crosses under a sewer. Support the sewer or drain lines to prevent settling and creaking the water main, as shown on the plans or as approved by the Engineer.
- D. Construction shall extend on each side of the crossing until the perpendicular distance from the water main to the sewer or drain line is at least ten feet.

3.3 WATER SERVICE LINES

- A. The horizontal and vertical separation between water service lines and all storm sewers, sanitary sewers, combined sewers or any drain or sewer service connection shall be the same as water main separation described above.
- B. Water pipe above shall be used for sewer service lines when minimum horizontal and vertical separation cannot be maintained.

3.4 CONSTRUCTION PROCEDURES

- A. Excavation: The Contractor shall do all excavation of whatever unclassified material is encountered to the depths established by Contractor. Trench depths, not established, shall be figured to allow a minimum of 5'-6" cover over the top of the pipe.
 - a. In open cut excavation, the Contractor shall keep the trench width at the top of the pipe not wider than established, unless the angle or repose of the soil is unsuitable.
- B. Pumping: The contractor shall remove, by pumping or other means, any water accumulated in the excavation and keep the trench dry during the pipe laying period. The contractor shall provide adequate pumps, well points, or other dewatering method at no extra cost to the Owner.
- C. Bedding: see drawings.
- D. Installation Of Pipe: Before lowering the pipe into the trench and while suspended, each pipe shall be inspected by the Contractor for defects. Defective, damaged or unsound pipe shall be immediately removed from the site. The interior of each pipe shall be inspected for cleanness and cleared of all dirt and foreign matter before being lowered into the trench.
 - a. Unless otherwise directed, pipe shall be laid with bell ends facing in the direction of laying. After a length of pipe is placed in the trench, the spigot shall be centered in the bell of the preceding pipe, the pipe shoved into position and brought to true alignment and there secured with sand tamped under and on each side of the pipe, excepting at bell holes. No earth or other foreign matter shall be allowed to enter into the joint space.
 - b. The bells, spigots and rubber gaskets shall then be thoroughly washed in soapy water so that no particles of sand or grit can damage the gasket. Slip-on joints shall be constructed in strict accordance with the manufacturer's recommendations.
- E. Cutting of Pipe: Where necessary to cut pipe, cutting shall be done with proper tools and cut end of pipe shall be square and regular. Cutting shall be done in strict conformance with manufacturer's instructions.
- F. Installation of Valves and Fittings: Before connecting valves or fitting to the pipe, such valves shall be cleaned and inspected by the Contractor for defects. Defective, damaged or unsound valves shall have a mechanical joint and be placed as established by contractor. All bolts, valves or fittings shall have thrust blocks as required set to undisturbed earth. All bolts shall be sufficiently tightened to manufacturer's recommendation.

G. Backfilling:

- a. Backfill of auxiliary valves and line valves, shall be carefully tamped to insure proper alignment. Contractor shall properly align and set to grade all valve boxes after completion of curb and gutter construction.
- b. Pipe Zone: see drawings.
- c. Granular Trench Backfill: All trenches and the excavation around fire hydrants, valves and other appurtenances which occur within the limits of existing or proposed pavements, sidewalks and curb and gutters, or where the edge of the trench shall be within two feet (2') of said improvements shall be backfilled with compacted granular backfill.
- d. Guarantee: The contractor shall guarantee all work for a period of one year after acceptance by the Owner. Any trenches improperly backfilled or where settlement occurs shall be reopened and properly compacted. The cost of any corrections and/or repair of any damages to other facilities shall be the responsibility of the Contractor.

3.5 ADJUSTMENT OF SHUT-OFF BOXES AND VALVE BOXES

- A. The Contractor is responsible for vertically adjusting existing water service shut-off boxes and valve boxes to the proper surface elevation as shown on Plans. The Contractor must obtain copies of information for water service pipe from the City of Evanston to verify and confirm the exact location of water shut-off boxes or valve boxes to be adjusted. The Contractor must notify the City of Evanston seventy-two (72) hours before the excavation of sidewalk or parkway commences to determine if the services are active and also to clarify any discrepancies with water service pipe plats and field survey.

3.6 TESTING, DISINFECTION, AND FLUSHING OF DOMESTIC WATER LINES

- A. Procedures shall be submitted to the local authorities for approval prior to testing. Tests shall be conducted using the more stringent procedures as approved by the Illinois Environmental Protection Agency (IEPA).
- B. General Contractor is responsible to drain down, pressure test, flush, chlorinate, and test all water lines. Provide all equipment and material necessary to test systems and provide for acceptable drain off of water. When flushing and draining systems General Contractor will drain the water to a location approved by the City of Evanston. Flush water must not drain to surface waters.
- C. Testing of the newly laid piping or any valved section of piping shall be accomplished after the lines are laid, the joints and accessories installed, and the trench partially backfilled, leaving the joint exposed for examination. The piping shall be subjected for a minimum of two hours to a pressure of one and one-half times the working pressure, but in no case less than 100 psi (689 kPa). Examine all exposed pipe, joints, fittings and accessories during the test period. Replace or repair defective portions of the system, and repeat tests until results are satisfactory.

Allowable leakage shall be as specified in AWWA C-600, Table 3 and as per IEPA requirements.

- D. All tapping sleeves and valves must be pressure tested with air prior to the start of the tapping process per City of Evanston requirements. Coordinate with the City of Evanston prior to construction.

3.7 DIRECT TAPPING OF DUCTILE IRON PIPE ENCASED IN POLYETHYLENE FILM

- A. Installation procedures must be a method as recommended by the Ductile Iron Pipe Research Association:
 - a. Method 1: Apply two (2) or three (3) wraps of polyethylene adhesive tape completely around the pipe to cover the area where the tapping machine and chain will be mounted. After the tapping machine is mounted, install the corporation stop directly through the tape and polyethylene. After the direct tap is completed, inspect the entire circumferential area for damage and repair as needed.
 - b. Method 2: Directly tap through the polyethylene film without applying a layer of tape on the encasement. Mount the tapping machine directly on the polyethylene encased pipe and install the corporation stop using normal tapping procedures. Once the direct service connection is completed, repair all polyethylene that may have been damaged during the procedure. Inspect the bottom of the encased pipe where the mounting chain has been in contact with the polyethylene for damage and repair as needed.
 - c. Method 3: Make an X-shaped cut in the polyethylene and temporarily fold back the film at the point where the corporation stop will be installed. Then mount the tapping machine over the exposed pipe surface and make the service tap. After the tap is made and the corporation installed, remove the tapping machine and repair the "X" shaped cut with polyethylene-compatible adhesive tape.
- B. Before backfilling. Inspect the polyethylene around the exposed circumferential area, particularly at the bottom where the mounting chain has been in contact with the polyethylene, to ensure that all damage is repaired.
- C. Coordinate with the City of Evanston for tapping of the existing water main prior to construction. Contractor to pay all fees to City of Evanston for water service tapping and inspection.

3.8 TEST FOR CONTROL

- A. The Contractor must test all services for flow. If the service has water flow, it must be connected to the new water main. Otherwise, the Contractor must terminate any services without water flow.

END OF SECTION

SECTION 33 4100 - SEWERAGE AND DRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes furnishing all labor, materials, tools, and equipment required to install the exterior storm and sanitary sewer systems as established by the Contractor in continuity to the plans and specification for the complete system. The work shall include but is not limited to excavation for sewer pipes and structures, sewer pipe and structure installation, backfilling trenches, and testing of the complete systems as required.
- B. Definitions:
 - 1. Drainage Piping: System of sewer pipe, fittings, and appurtenances for gravity flow of storm drainage.
- C. Related Section
 - 1. Section 31 2317 Excavating, Backfilling and Compacting for Utilities
 - 2. Section 31 2214 Earthwork for Sitework

1.2 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Section "Submittal Procedures."
- B. Shop drawings for precast concrete manholes and other structures. Include frames, covers, and grates.
- C. Inspection and test reports specified in the "Field Quality Control" Article.

1.3 QUALITY ASSURANCE

- A. Environmental Agency Compliance: Comply with regulations pertaining to sanitary sewerage and storm drainage systems.
- B. Utility Compliance: Comply with regulations pertaining to sanitary sewerage and storm drainage systems. Include standards of water and other utilities where appropriate.
- C. Product Options: Drawings indicate sizes, profiles, connections, and dimensional requirements of system components and are based on specific manufacturer types indicated. Other manufacturers' products with equal performance characteristics may be considered. Refer to Division 01 Section "Product Substitutions."

1.4 PERFORMANCE REQUIREMENTS

- A. Gravity-Flow, Nonpressure-Piping Pressure Ratings: At least equal to system test pressure.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect pipe, pipe fittings, and seals from dirt and damage.
- B. Handle precast concrete manholes and other structures according to manufacturer's rigging instructions.

1.6 PROJECT CONDITIONS

- A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.
- B. Existing Utilities: Do not interrupt existing utilities serving facilities occupied by the Owner or others except when permitted under the following conditions and then only after arranging to provide acceptable temporary utility services.
 - 1. Notify Architect not less than 48 hours in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without receiving Architect's written permission.

1.7 SEQUENCING AND SCHEDULING

- A. Coordinate with other utility work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements of Division 01 Sections.

2.2 PIPES AND FITTINGS

- A. All pipe material shall conform to MWRD standards and requirements.
- B. PVC: SDR-26 ASTM D 3034
- C. Perforated pipe: ASTM D 3034; PVC-SDR-26. Provide four rows of perforations meeting AASHTO M278 specifications. Joints ASTM D 2855 or ASTM D 3212.
- D. Reinforced Concrete Pipe, minimum class IV unless otherwise indicated on the plans. Conform to ASTM C-76 with joints conforming to ASTM C-443.
- E. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
 - 1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - 2. Gaskets: AWWA C111, rubber.

2.3 MANHOLES

- A. Precast Concrete Manholes: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for rubber gasket joints.
1. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent floatation.
 2. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (100-mm) minimum thickness for walls and base riser section, and having a separate base slab or base section with integral floor.
 3. Riser Sections: 4-inch (100-mm) minimum thickness, 48-inch (1220-mm) diameter, and lengths to provide depth indicated.
 4. Top Section: Eccentric cone type, unless concentric cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
 5. Gaskets: ASTM C 443 (ASTM C 443M), rubber.
 6. Grade Rings: Include 2 reinforced-concrete rings, of 6- to 8-inch (152- to 229-mm) total thickness, that match a 24-inch- (610-mm-) diameter frame and cover.
 7. Steps: ASTM C 478 (ASTM C 478M) individual steps or ladder. Omit steps for manholes less than 60 inches (1500 mm) deep.
 8. Pipe Connectors: ASTM C 923 (ASTM C 923M), resilient, of size required, for each pipe connecting to base section.
 9. Precast subsurface structures shall be rated to accommodate AASHTO HS-20 loading.
- B. Manhole Frames and Covers: ASTM A-48, Class 35B, cast gray iron. Equip on-site manhole covers with lock-bolt or approved locking mechanism device. Include indented top design with lettering cast into cover:
1. Storm Drainage Piping Systems: Raised flush letters per current code.
 2. Install ADA [American Disabilities Act] approved grates for catch basins located within pedestrian path of travel (within property limits only).
 3. Pipe Connectors: ASTM C 923 (ASTM C 923M), resilient, of size required, for each pipe connecting to base section.
 4. Precast subsurface structures shall be rated to accommodate AASHTO HS-20 loading.

2.4 CATCH BASINS

- A. Precast Concrete Catch Basins: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for rubber gasket joints.
1. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (100-mm) minimum thickness for walls and base riser section, and having a separate base slab or base section with integral floor.
 2. Riser Sections: 4-inch (100-mm) minimum thickness; 48-inch (1220-mm) diameter, and lengths to provide depth indicated.
 3. Top Section: Eccentric cone type, unless concentric cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.

4. Gaskets: ASTM C 443 (ASTM C 443M), rubber.
5. Grade Rings: Include 2 or 3 reinforced-concrete rings, of 6- to 9-inch (152- to 229-mm) total thickness, that match a 24-inch- (610-mm-) diameter frame and grate.
6. Steps: ASTM C 478 (ASTM C 478M) individual steps or ladder. Omit steps for catch basins less than 60 inches (1500 mm) deep.
7. Pipe Connectors: ASTM C 923 (ASTM C 923M), resilient, of size required, for each pipe connecting to base section.

B. Frames and Grates:

1. See drawings for details.

2.5 CLEANOUTS

- A. See drawings for details.

2.6 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

- B. Structures: Portland-cement design mix, 4000 psi (27.6 MPa) minimum, with 0.45 maximum water-cement ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615, Grade 60 (ASTM A 615M, Grade 400), deformed steel.

2.7 TRANSITION AND PIPE COUPLINGS

- A. Pipe transitions and Pipe couplings shall be water tight couplings with stainless steel band clamps or approved equal.

2.8 PROTECTIVE COATINGS

- A. General: Include factory- or field-applied protective coatings to structures and appurtenances according to the following:

- B. Coating: 1- or 2-coat, coal-tar epoxy, 15-mil (0.381-mm) minimum thickness, except where otherwise indicated.

1. Manholes: On exterior and interior surfaces.
2. Manhole Frames and Covers: On interior surfaces.

3. Catch Basins: On exterior and interior surfaces.
4. Catch Basin Frames and Grates: On interior surfaces.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 31 2317 "Excavating, Backfilling, and Compacting for Utilities"

3.2 IDENTIFICATION

- A. Install green warning tapes directly over piping and at outside edges of underground structures.
 1. Use warning tapes or detectable warning tape over ferrous piping.
 2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.3 INSTALLATION, GENERAL

- A. General Locations and Arrangements: Drawings (plans and details) indicate the general location and arrangement of underground sewerage and drainage systems piping. Location and arrangement of piping layout take into account many design considerations. Install piping as indicated, to extent practical.
- B. Install piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's recommendations for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.
- C. Install gravity-flow-systems piping at constant slope between points and elevations indicated. Install straight piping runs at constant slope, not less than that specified, where slope is not indicated.
- D. Install piping pitched down in direction of flow, at minimum slope of 1 percent (1:100) and 36-inch (1000-mm) minimum cover, except where otherwise indicated.

3.4 MANHOLE INSTALLATION

- A. General: Install manholes, complete with accessories, as indicated.
- B. Set tops of frames and covers flush with finished surface where manholes occur in pavements. Set tops 3 inches (76 mm) above finished surface elsewhere, except where otherwise indicated.
- C. Place precast concrete manhole sections as indicated, and install according to ASTM C 891.
 1. Provide rubber joint gasket complying with ASTM C 443 (ASTM C 443M), at joints of sections.
 2. Apply bituminous mastic coating at joints of sections.

3.5 TAP CONNECTIONS

- A. Make connections to existing piping and underground structures so finished work conforms as nearly as practical to requirements specified for new work.
- B. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch (150-mm) overlap, with not less than 6 inches (150 mm) of 3000-psi (20.7-MPa), 28-day, compressive-strength concrete.
- C. Make branch connections from side into existing piping, sizes 4 to 20 inches (100 to 500 mm) by removing a section of existing pipe and installing a wye fitting into existing piping. Encase entire wye with not less than 6 inches (150 mm) of 3000-psi (20.7-MPa), 28-day, compressive-strength concrete.
 - 1. Use concrete that shall attain a minimum 28-day compressive strength of 3000 psi (20.7 MPa), unless otherwise indicated.
 - 2. Use epoxy bonding compound as an interface between new and existing concrete and piping materials.
- D. Protect existing piping and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.6 FIELD QUALITY CONTROL

- A. Clear interior of piping and structures of dirt and superfluous material as the work progresses. Maintain swab or drag in piping and pull past each joint as it is completed.
 - 1. In large, accessible piping, brushes and brooms may be used for cleaning.
 - 2. Place plug in end of incomplete piping at end of day and whenever work stops.
 - 3. Flush piping between manholes and other structures, if required by authorities having jurisdiction, to remove collected debris.
- B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of the Project.
 - 1. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visual between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of a ball or cylinder of a size not less than 92.5 percent of piping diameter.
 - c. Crushed, broken, cracked, or otherwise damaged piping.
 - d. Improper infiltration: Water leakage into piping.
 - e. Improper exfiltration: Water leakage from or around piping.
 - 2. Replace defective piping using new materials and repeat inspections until defects are within allowances specified.
 - 3. Reinspect and repeat procedure until results are satisfactory.

- C. Test new piping systems and parts of existing systems that have been altered, extended, or repaired for leaks and defects.
1. Do not enclose, cover, or put into service before inspection and approval.
 2. Test completed piping systems according to authorities having jurisdiction.
 3. Schedule tests and inspections with at least 24 hours' advance notice.
 4. Submit separate reports for each test.
 5. Where authorities having jurisdiction do not have published procedures, perform tests as follows:
 - a. Sanitary Sewerage: Perform hydrostatic test
 - 1) Allowable leakage is a maximum of 50 gallons per inch nominal pipe size, for every mile pipe, during a 24-hour period.
 - 2) Close openings in system and fill with water.
 - 3) Purge air and refill with water.
 - 4) Disconnect water supply.
 - 5) Test and inspect joints for leaks.
 - 6) Option: Test ductile-iron piping according to AWWA C600, Section 4 "Hydrostatic Testing." Use test pressure of a least 10 psig (69.0 kPa).
 - b. Sanitary Sewerage: Perform air test according to UNI-B-6.
 - c. Storm Drainage: Perform hydrostatic test.
 - 1) Allowable leakage is a maximum of 200 gallons per inch nominal pipe size, for every mile of pipe, during a 24-hour period.
 - 2) Close openings in system and fill with water.
 - 3) Purge air and refill with water.
 - 4) Disconnect water supply.
 - 5) Test and inspect joints for leaks.
 - 6) Storm Drainage: Perform hydrostatic test. Close opening in system and fill with water to not less than 10-foot (3-m) head of water. Disconnect water supply. Water level must not drop for 15 minutes. Inspect joints for leaks.
 - d. Storm Drainage: Perform air test according to UNI-B-6.

END OF SECTION

SECTION 33 46 00 - SUBDRAINAGE

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. Perforated-wall pipe and fittings.
 - 2. Drainage conduits.
- B. Related Requirements:
 - 1. Section 31 32 19 "Geosynthetic Soil Stabilization And Layer Separation."

1.3 PERMITS AND FEES

- A. Permits: The Contractor shall secure and pay for all permits, inspections, and certificates of inspection of any governmental and inspection body having jurisdiction over all or any part of the work included under this section and/or such inspections etc., required by these specifications.
- B. Fees: The Contractor shall secure and pay for all fees and assessments in connection with the work under this contract and shall include this cost in its bid and contract price.

1.4 PRE-INSTALLATION MEETINGS

- A. Pre-installation Meeting: Conduct meeting at Project Site, Manufacturer's Facility of Fabricator's Shop. Confirm with Owner and Landscape Architect 14 days prior to conference.
 - 1. Before submitting submittals, review submittals, mockup and other requirements of this section and examine procedures for ensuring quality of the scope herein. Require representatives of each entity directly concerned with the scope herein, including but not limited to, the following:
 - a. Contractor's superintendent.
 - b. Subcontractor.
 - c. Special Subcontractor.
 - d. Independent testing agency responsible for testing.
 - e. Product manufacturer and/or local representative.
 - f. Authority Having Jurisdiction.

- g. Landscape Architect.
- 2. Review methods and procedures related to the work of this section, including but not limited to, the following:
 - a. Responsibilities of each party.
 - b. Coordination of Landscape Architect's review of the work, including but not limited to:
 - 1) Site or Shop Visits to Review Samples and Mockups
 - 2) Site Visits to Observe General Construction Progress
 - 3) Site or Shop Visits to Review Fabrication Progress
 - 4) Site Visits to Review First Work In Place
 - 5) Site Visits for Punch List Review
 - 6) Site Visits for Punch List Completion Review
 - 7) Site Visit for Warranty Review
 - c. Lines of authority and communication for the project. Procedures for resolution of any project document ambiguity.
 - d. Methods for documenting, reporting, and distributing documents and reports.
 - e. Proposed sources of materials.
 - f. Procedures for packaging and storing archive samples.
 - g. Review of the time schedule for all installation and testing. Schedule of workdays and/or starting times if third party testing verification is required.
 - h. Quality control.
 - i. Temperature and weather limitations. Installation procedures for adverse weather conditions. Defining acceptable subgrade or ambient moisture and temperature conditions for working during installation.
 - j. Subgrade conditions, dewatering responsibilities, and subgrade maintenance plan.
 - k. Deployment techniques including allowable subgrade conditions.
 - l. Construction, material placement, and backfilling.
 - m. Requirements for protecting work, including restriction of traffic and adjacent work impacting during installation period and for remainder of construction period.
 - n. Measurement and payment schedules.
 - o. Health and safety.
 - p. Procedures and responsibilities for preparation and submission of as-built drawings.

1.5 COORDINATION

- A. Refer to Division 1 Requirements.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product submit the following:
 - 1. Manufacturer's Product Literature and Specification Data.
 - 2. Manufacturer's written instructions for recommended maintenance practices.
 - 3. Written manufacturer's warranty.
 - 4. Product liability insurance certificate with project owner as certificate holder.

5. MSDS for items in Part 2 “Products.” Drainage conduits, including rated capacities.
 6. Drainage panels, including rated capacities.
 7. Geotextile filter fabrics.
- B. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.
- C. Samples for Verification: For each type of product, prepared as Samples of size indicated below:
1. Subdrainage product: 6 inch (15.24 cm) linear sample of each product.
 2. Bulk Materials: 1 lbs (.45 kg) by weight of each product.
- D. Shop Drawings: Prepared by or under the supervision of a qualified professional, detailing fabrication and assembly.
1. Submit shop drawings within a reasonable time so as not to delay the start of material fabrication and installation.
 2. Submit shop drawings per above allowing a minimum review time of 10 business days for review and response. Per above, also allow enough time for revisions and resubmittal where reasonably predictable.
 3. Shop drawings shall show the proposed layout identifying all components and details based on field verified conditions and measurements.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer of subdrainage products, subdrainage manufacturer and testing agency.
- B. Material Certificates: For the following, from manufacturer:
1. Subdrainage products.
 2. Bulk materials.
- C. Material Test Reports: For each of the following:
1. Aggregates: Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
- D. Preconstruction test reports.
- E. Source quality-control test reports.
- A. Field quality-control and special inspection reports.
- B. Minutes of pre-installation conference.
- C. Maintenance Instructions.

- D. Warranty: Written manufacturer's warranty.

1.8 CLOSEOUT SUBMITTALS

- A. Maintenance Data: From Installer including a recommended maintenance plan with procedures for inspection and care during a calendar year. Submit before start of required warranty and maintenance periods

1.9 QUALITY ASSURANCE

- A. Contractor shall establish and maintain a quality assurance program for the purposes of managing the quality of the work. Quality assurance program shall consist of plans, procedures and organizational design necessary to ensure that work of this Section meets the prescriptive and performance requirements specified. The Quality Control, Source Quality Control and Site Quality Control provisions specified elsewhere in this Section shall form part of the Quality Assurance Program.
- B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements Authorities Having Jurisdiction for all work included in this section.
- C. Codes and Standards: Conform work to all applicable codes and standards.
- D. Manufacturer Qualifications: Provide manufacturer qualifications as follows:
 - 1. Submit a list of ten completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.
 - 2. Submit qualifications of manufacturer.
 - 3. Submit manufacturer's quality control program.
 - 4. Submit example of Material Warranty and any other applicable warranties.
- E. Installer Qualifications: Provide installer qualifications as follows:
 - 1. Submit a list of ten completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.
 - 2. Submit resumes and/or qualifications of installation manager(s).
 - 3. Submit fabrication quality control program.
 - 4. Submit installation quality control program.
 - 5. Submit example of Material Warranty and any other applicable warranties.

1.10 DELIVERY, STORAGE AND HANDLING

- A. Deliver packaged products in an undamaged condition in original containers, displaying manufacturer's labels, along with instructions for handling, storing, unpacking, protecting, and installing.

- B. Deliver and store materials in manufacturer's original containers, with seals unbroken and identification labels intact until time of use.
- C. Deliver products to achieve the shortest duration of storage time as practicable.
- D. Deliver all chemical products in original, unopened containers with original labels intact and legible, which state the guaranteed chemical analysis. Store all chemicals in weather protected enclosure.
- E. Comply with manufacturer's written instructions for delivery, storage, and handling, and as required to prevent damage to products and work during construction.
- F. Store products and materials in a neat and orderly manner. Maintain clear aisles and access to work areas. Protect stored products from theft and damage. Store products above ground in weathertight, ventilated packaging or enclosures.
- G. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.
- H. Store liquids in tightly closed containers protected from freezing.
- I. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- J. 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 materials with appropriate certificates.

1.11 FIELD CONDITIONS

- A. Existing Utilities: do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect not less than [two] <Insert number> days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.
- B. Field Measurements: Verify actual locations of all site elements and other construction contiguous with the work of this section prior to fabrication and/or installation.

- C. The work shall not occur in the presence of standing water, mud, snow, or frozen subgrade conditions. Work shall not occur while precipitation is occurring or during excessive winds, or when temperatures are outside the limits specified in this specification. Work completed during these conditions will be rejected.
- D. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- E. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
- F. Hot-Weather Requirements: Comply with hot-weather construction requirements.

1.12 EXCAVATING AND GRADING AROUND UTILITIES

- A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.
- B. Determine location of underground utilities and perform work in a manner that will avoid damage. Hand excavate as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.
- C. Notification of the utility locate services is required for all Excavation and grading deeper than 12 inches: The Contractor is responsible for knowing the location and avoiding utilities that are not covered by the local utility locator service.

1.13 OBSERVATION OF THE WORK

- A. The Landscape Architect may observe the work at any time. They may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting specifications shall be paid by the Contractor.
- B. The Landscape Architect shall be informed of the progress of the work so the work may be observed during key times in the construction process. The Landscape Architect shall be afforded sufficient time to schedule visits to the site. Failure of the Landscape Architect to make field observations shall not relieve the Contractor from meeting all the requirements of this specification.

1.14 FIRST WORK IN PLACE

- A. The Landscape Architect shall be informed once the first work in place has been completed for all individual elements included in this section for review to ensure the work is proceeding in accordance with the approved samples and mockups and per the Contract Documents. The Landscape Architect shall be afforded sufficient time to schedule visits to the site for review. In

the event that sufficient time cannot be provided the Contractor shall provide images from multiple angles and perspectives of the work for Landscape Architect review.

1.15 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering and wear.
 - b. Separation or delamination of materials and components.
 - 2. Warranty Period: One year from date of Substantial Completion.

1.16 MAINTENANCE SERVICE

- A. Contractor to provide standard industry maintenance on all scope items herein until Final Acceptance.

PART 2 - PRODUCTS

2.1 ATRIUM DRAIN IN PLANTING

- A. Model NDS 70. 3” Round Atrium Drain. Color: black. NDS, website: www.ndspro.com telephone: 888-825-4716.

2.2 FLUSH LANDSCAPE DRAIN IN LAWN

- A. Model 50. 6” Round Grate and Basin. Color: green. NDS, website: www.ndspro.com telephone: 888-825-4716.

2.3 DRAIN LINES AND PERFORATED DRAIN LINES

- A. Schedule 40 PVC double wall solid pipe. Pipe, manufactured from virgin, low filler cell class PVC resin (12454 per ASTM D1784). Pipe shall be Contech A-2000 as manufactured by Contech construction Products, Inc, Chicago IL Phone 630 573 1110, www.contech-cpi.com. All fittings, "T", "Y", end caps, and splices shall be compatible fittings by the same manufacturer. Size – 8” diameter for all main lines, 4” diameter for all secondary lines.
- B. Schedule 40 PVC double wall perforated pipe. Pipe, manufactured from virgin, low filler cell class PVC resin (12454 per ASTM D1784). Pipe shall have slots on the bottom quadrant of the pipe. Pipe shall be Contech A-2000 as manufactured by Contech construction Products, Inc, Chicago IL Phone 630 573 1110, www.contech-cpi.com. All fittings, "T", "Y", end caps, and splices shall be compatible fittings by the same manufacturer. Size - 4” diameter.

2.1 PERFORATED-WALL PIPES AND FITTINGS

A. Perforated PE Pipe and Fittings:

1. NPS 6 (DN 150) and Smaller: ASTM F 405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
2. NPS 8 (DN 200) and Larger: ASTM F 667; AASHTO M 252, Type CP; or AASHTO M 294, Type CP; corrugated; for coupled joints.
3. Couplings: Manufacturer's standard, band type.

B. Perforated PVC Sewer Pipe and Fittings: ASTM D 2729, bell-and-spigot ends, for loose joints.

2.2 SOIL MATERIALS

A. Soil materials are specified in Section 32 91 13 "Soil Preparation."

2.3 WATERPROOFING FELTS

A. Material: Comply with ASTM D 226, Type I, asphalt or ASTM D 227, coal-tar-saturated organic felt.

2.4 GEOTEXTILE FILTER FABRICS

A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. (4480 to 13 440 L/min. per sq. m) when tested according to ASTM D 4491.

B. Structure Type: Nonwoven, needle-punched continuous filament.

1. Survivability: AASHTO M 288 Class 2.
2. Styles: Flat and sock.

PART 3 - EXECUTION

3.1 INSPECTION

A. Prior to installation examine site to confirm that existing conditions are satisfactory for the work of this section to proceed.

B. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope toward the under drain lines as shown on the drawings.

C. Confirm that no adverse drainage conditions are present.

D. Confirm that no conditions are present which are detrimental to plant growth.

- E. Confirm that utility work has been completed per the drawings.
- F. If unsatisfactory conditions are encountered, notify the Landscape Architect immediately to determine corrective action prior to proceeding.

3.2 EXAMINATION

- A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.
- B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.
- C. Verify that drainage panels installed as part of foundation wall waterproofing is properly positioned to drain into subdrainage system.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 COORDINATION WITH PROJECT WORK

- A. The Contractor is responsible for investigating, and being aware of, the work requirements of their sub-contractors and other contractors. The Contractor shall coordinate with all other work that may impact the completion of the work herein.
- B. Prior to the start of work, prepare a detailed schedule of the work for coordination with other trades.

3.4 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 31 20 00 "Earth Moving."

3.5 FOUNDATION DRAINAGE INSTALLATION

- A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches (150 mm) deep and 12 inches (300 mm) wide.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).
- D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with tape.

- E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for foundation subdrainage.
- F. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.
- G. After satisfactory testing, cover drainage piping to width of at least 6 inches (150 mm) on side away from footing and above top of pipe to within 12 inches (300 mm) of finish grade.
- H. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
- I. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches (100 mm).
- J. Install drainage panels on foundation walls as follows:
 - 1. Coordinate placement with other drainage materials.
 - 2. Lay perforated drainage pipe at base of footing. Install as indicated in Part 3 "Piping Installation" Article.
 - 3. Separate 4 inches (100 mm) of fabric at beginning of roll and cut away 4 inches (100 mm) of core. Wrap fabric around end of remaining core.
 - 4. Attach panels to wall beginning at subdrainage pipe. Place and secure molded-sheet drainage panels, with geotextile facing away from wall.
- K. Place backfill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

3.6 UNDERSLAB DRAINAGE INSTALLATION

- A. Excavate for underslab drainage system after subgrade material has been compacted but before drainage course has been placed. Include horizontal distance of at least 6 inches (150 mm) between drainage pipe and trench walls. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).
- D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with tape.
- E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for underslab subdrainage.
- F. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.

- G. After satisfactory testing, cover drainage piping with drainage course to elevation of bottom of slab, and compact and wrap top of drainage course with flat-style geotextile filter fabric.
- H. Install horizontal drainage panels as follows:
 - 1. Coordinate placement with other drainage materials.
 - 2. Lay perforated drainage pipe at inside edge of footing.
 - 3. Place drainage panel over drainage pipe with core side up. Peel back fabric and wrap fabric around pipe. Locate top of core at bottom elevation of floor slab.
 - 4. Butt additional panels against other installed panels. If panels have plastic flanges, overlap installed panel with flange.

3.7 RETAINING-WALL DRAINAGE INSTALLATION

- A. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- B. Place supporting layer of drainage course over compacted subgrade to compacted depth of not less than 4 inches (100 mm).
- C. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with tape.
- D. Install drainage piping as indicated in Part 3 "Piping Installation" Article for retaining-wall subdrainage.
- E. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.
- F. After satisfactory testing, cover drainage piping to width of at least 6 inches (150 mm) on side away from footing and above top of pipe to within 12 inches (300 mm) of finish grade.
- G. Place drainage course in layers not exceeding 3 inches (75 mm) in loose depth; compact each layer placed and wrap top of drainage course with flat-style geotextile filter fabric.
- H. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches (100 mm).
- I. Install drainage panels on wall as follows:
 - 1. Coordinate placement with other drainage materials.
 - 2. Lay perforated drainage pipe at base of footing as described elsewhere in this Specification. Do not install aggregate.
 - 3. If weep holes are used instead of drainage pipe, cut 1/2-inch- (13-mm-) diameter holes on core side at weep-hole locations. Do not cut fabric.
 - 4. Mark horizontal chalk line on wall at a point 6 inches (150 mm) less than panel width above footing bottom. Before marking wall, subtract footing width.
 - 5. Separate 4 inches (100 mm) of fabric at beginning of roll and cut away 4 inches (100 mm) of core. Wrap fabric around end of remaining core.

6. Attach panel to wall at horizontal mark and at beginning of wall corner. Place core side of panel against wall. Use concrete nails with washers through product. Place nails from 2 to 6 inches (50 to 150 mm) below top of panel, approximately 48 inches (1200 mm) apart. Construction adhesives, metal stick pins, or double-sided tape may be used instead of nails. Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
 7. If another panel is required on same row, cut away 4 inches (100 mm) of installed panel core and wrap fabric over new panel.
 8. If additional rows of panel are required, overlap lower panel with 4 inches (100 mm) of fabric.
 9. Cut panel as necessary to keep top 12 inches (300 mm) below finish grade.
 10. For inside corners, bend panel. For outside corners, cut core to provide 3 inches (75 mm) for overlap.
- J. Fill to Grade: Place satisfactory soil fill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Fill to finish grade.

3.8 LANDSCAPING DRAINAGE INSTALLATION

- A. Provide trench width to allow installation of drainage conduit. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).
- D. Install drainage conduits as indicated in Part 3 "Piping Installation" Article for landscaping subdrainage with horizontal distance of at least 6 inches (150 mm) between conduit and trench walls. Wrap drainage conduits without integral geotextile filter fabric with flat-style geotextile filter fabric before installation. Connect fabric sections with tape.
- E. Add drainage course to top of drainage conduits.
- F. After satisfactory testing, cover drainage conduit to within 12 inches (300 mm) of finish grade.
- G. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
- H. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches (100 mm).
- I. Fill to Grade: Place satisfactory soil fill material over drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Fill to finish grade.

3.9 PIPING INSTALLATION

- A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.
 - 1. Foundation Subdrainage: Install piping level and with a minimum cover of 36 inches (915 mm) unless otherwise indicated.
 - 2. Underslab Subdrainage: Install piping level.
 - 3. Plaza Deck Subdrainage: Install piping level.
 - 4. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping level and with a minimum cover of 36 inches (915 mm) unless otherwise indicated.
 - 5. Landscaping Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches (915 mm) unless otherwise indicated.
 - 6. Lay perforated pipe with perforations down.
 - 7. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.
- B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.
- C. Install thermoplastic piping according to ASTM D 2321.

3.10 PIPE JOINT CONSTRUCTION

- A. Join perforated PE pipe and fittings with couplings according to ASTM D 3212 with loose banded, coupled, or push-on joints.
- B. Join perforated PVC sewer pipe and fittings according to ASTM D 3212 with loose bell-and-spigot, push-on joints.
- C. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.11 BACKWATER VALVE INSTALLATION

- A. Comply with requirements for backwater valves specified in Section 33 41 00 "Storm Utility Drainage Piping."
- B. Install horizontal backwater valves in header piping downstream from perforated subdrainage piping.
- C. Install horizontal backwater valves in piping in manholes or pits where indicated.

3.12 CLEANOUT INSTALLATION

- A. Comply with requirements for cleanouts specified in Section 334100 "Storm Utility Drainage Piping."
- B. Cleanouts for Foundation, Retaining-Wall and Landscaping Subdrainage:
 - 1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
 - 2. In vehicular-traffic areas, use NPS 4 (DN 100) cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep. Set top of cleanout flush with grade.
 - 3. In nonvehicular-traffic areas, use NPS 4 (DN 100) PVC pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 12 by 12 by 4 inches (300 by 300 by 100 mm) deep. Set top of cleanout 1 inch (25 mm) above grade.
 - 4. Comply with requirements for concrete specified in Section 03 30 00 "Cast-in-Place Concrete."
- C. Cleanouts for Underslab Subdrainage:
 - 1. Install cleanouts and riser extensions from piping to top of slab. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
 - 2. Use NPS 4 (DN 100) cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout flush with top of slab.

3.13 CONNECTIONS

- A. Comply with requirements for piping specified in Section 33 41 00 "Storm Utility Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect low elevations of subdrainage system to building's solid-wall-piping storm drainage system.
- C. Where required, connect low elevations of foundation or underslab subdrainage to stormwater sump pumps. Comply with requirements for sump pumps specified in Section 22 14 29 "Sump Pumps."

3.14 GRADE, ELEVATION AND ALIGNMENT CONTROL

- A. Provide grade and elevation control during installation of the work of this section. Utilize grade stakes, string lines, surveying equipment, and other means and methods to assure that grades and contours conform to the grades indicated on the plans.

- B. Provide alignment control during installation of the work of this section. Utilize stakes, pins, marking techniques, string lines, surveying equipment, and other means and methods to assure that alignments conform to the alignments on the plans.

3.15 IDENTIFICATION

- A. Arrange for installation of green warning tapes directly over piping. Comply with requirements for underground warning tapes specified in specified in Section 31 20 00 "Earth Moving."
 - 1. Install PE warning tape or detectable warning tape over ferrous piping.
 - 2. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.16 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.
 - 2. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.
- B. Drain piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.17 REPAIR AND REPLACEMENT

- A. General: Repair or replace that is damaged by construction operations, in a manner approved by Landscape Architect.

3.18 WASTE HANDLING

- A. General: Handle waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

3.19 CLEANING

- A. The contractor should clean the job site and remove any excess materials. Coordinate with Owner for storage locations for any Attic Stock materials where applicable.
- B. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

3.20 PROTECTION

- A. Contractor shall furnish and install construction fence around new installations to prevent access. Fencing shall be maintained in place for a minimum of 48 hours after completion of installation, or as directed by the Landscape Architect. Drying period may take longer due to weather conditions.
- B. Contractor shall notify Landscape Architect that landscape irrigation shall be restricted near installations until applicable drying period is complete. Standing water on installations shall be restricted at all times.

3.21 MAINTENANCE SERVICE

- A. Maintenance Service: Provide maintenance by skilled employees of Installer or approved Subcontractor. Maintain as required in "Maintenance" Article. Begin maintenance immediately after scope is installed and continue until final acceptance.

3.22 DEMONSTRATION AND TRAINING

- A. Engage a manufacturer-authorized service representative and/or other authorized professional to train Owner's maintenance personnel to adjust and operate all components herein.
- B. Train Owner's maintenance personnel in proper maintenance procedures for all components herein.

END OF SECTION - 33 46 00