



UNIVERSITY
OF KENTUCKY

Purchasing Division

CAPITAL CONSTRUCTION

Invitation for Bid

CCK-1992-15

Proposal Due Date- 11-25-14

Renovate/Upgrade Soccer/Softball Locker Rooms

Project #2401.0

Volume 2

**PROJECT #2401.0
RENOVATE/UPGRADE SOCCER/SOFTBALL LOCKER ROOMS
UNIVERSITY OF KENTUCKY
LEXINGTON, KENTUCKY**

INVITATION TO BID: CCK-1992-15
OPENING: NOVEMBER 25, 2014
@ 3:00 P.M. LEXINGTON TIME

PRE-BID CONFERENCE:
NOVEMBER 12, 2014 @ 9:00 AM
SOCCER/SOFTBALL COMPLEX
LEXINGTON, KY 40506

DATE ISSUED: OCTOBER 29, 2014

UNIVERSITY OF KENTUCKY
CAPITAL CONSTRUCTION PROCUREMENT
ROOM 238 PETERSON SERVICE BUILDING
411 PETERSON SERVICE BUILDING
LEXINGTON, KY 40506-0005

POST-BID CONFERENCE
TIME AND PLACE TO BE
ANNOUNCED AT BID OPENING

CONSULTANTS

BRANDSTETTER CARROLL, INC
2360 CHAUVIN DRIVE
LEXINGTON, KY 40517

KLH ENGINEERS
333 EAST MAIN STREET
LEXINGTON, KY 40507 .

CONTACT THE FOLLOWING INDIVIDUALS FOR MORE INFORMATION:

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METHOD OF AWARD

FINAL AWARD OF CONTRACT WILL BE MADE ON THE BASIS OF THE LOWEST, RESPONSIVE AND RESPONSIBLE BID, WHICH OFFERS THE BEST VALUE.

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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 general requirements for fire-suppression systems.
- B. Examine the drawings, specifications, and visit the site prior to submitting a bid.
- C. The base bid shall include furnishing all materials, labor, tools, equipment and installation of all work required to install complete fire-suppression systems as outlined in Division-21.
- D. Products and Topics in this Section Include:
 - 1. Definitions.
 - 2. Submittals.
 - 3. Supplemental Engineering Services.
 - 4. Interpretation of Documents.
 - 5. Electronic Files.
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 - 22. Substitutions.
 - 23. Explanation and Precedence of Drawings and Specifications
 - 24. Cutting, Patching, and Demolition.
 - 25. System Tests.
 - 26. Excavating and Backfilling.

27. Cleaning Premises.
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29. Project Site Safety
30. Work in Existing Spaces.
31. Fire Alarm Work Related to Fire-suppression Systems.
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1.3 DEFINITIONS

- A. Acceptance Testing Authorities (ATA): The individuals and/or business entities that participate in Acceptance Testing and report to the Owner when work appears to be complete. These parties represent the interest of the Owner.
- B. Authority Having Jurisdiction (AHJ): The governmental agency or sub-agency having authority over the construction process and having the ultimate authority to enforce, uphold and rule on codes and safety compliance at the project site.
- C. Contractor: The entity(s) contractually responsible for performing work of this Division.
- D. Wherever the words "Site," "Project Site," or "Premises" appear in these specifications or related drawings, it shall be interpreted to mean real estate, buildings and structures where work shall be performed and where products shall be installed and reside.
- E. Commissioning Authority: An agent of the Owner, often independent of the design team, responsible for ensuring compliance with the Owner's project intent. The commissioning authority represents the interest of the Owner.
- F. Contractor of Record: A business entity entering into a contract for any element of work defined in the Project Documents directly with the Owner, directly with the Construction Manager or directly with a General Contractor.
- G. Designer: The Consultant(s) representing the Owner and directly responsible for specification of work within this Division, including related drawings. The Designer may or may not be affiliated with the architectural or an engineering firm of record for the Project. The Designer is a member of the project Design Team.
- H. Furnish: To supply product or labor (context dependent) including associated shipping, storage, travel, lodging, miscellaneous and warranty expenses.
- I. Install: To supply labor, tools and incidental materials necessary to handle, store, mount, terminate, program, configure and adjust a product in order to fulfill the requirements of the Project.

- J. Provide: To furnish and install, inclusive of accessories, modules, and ancillary items necessary to render the respective product and system fully operational and usable to the Owner for the intended purpose.
- K. Substantial Completion Division 21 only:
 - 1. The point in the Project where work of this Division that occurs at the project site has been completed. For work to be substantially complete, the following must be valid:
 - a. Products have been delivered and installed at the project site, and;
 - b. Systems have been installed, tested, adjusted and are operational for their intended purpose, and;
 - c. Products have been labeled in accordance with the Contract Documents, and;
 - d. Systems are performing in accordance with the design intent, and;
 - e. Systems have been demonstrated to the Owner as complete and working.
- L. Supply: Used interchangeably with “furnish.” See “Furnish.”
- M. This Division: This Section and each specification section beginning with the same two digit number.
- N. Work: The supply of products, materials, labor, incidentals and services necessary to fulfill the requirements of the Project.

1.4 SUBMITTALS

- A. General:
 - 1. Comply with Section 21 05 03.00 “Submittals for Fire-Suppression.”
- B. Product Data (PD):
 - 1. Provide product datasheets for all fire-suppression materials, components, valves, devices, and equipment. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories
- C. Shop Drawings (SD), Delegated-Design Submittal: For fire-suppression systems in compliance with performance requirements and design criteria, all applicable codes, the authority having jurisdiction, and NFPA guidelines. Shop Drawings and associated hydraulic calculations shall be signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include water flow test data and calculations on the drawings.
 - 3. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - a. Items penetrating finished ceiling include the following:

- 1) Lighting fixtures.
- 2) Air outlets and inlets.
- b. Coordinate with all equipment, piping, conduit, ductwork, from other contractors.

D. Closeout Submittals (CO):

1. Provide operation and maintenance manuals for all fire-suppression components, valves, devices, and equipment.
2. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA. Include "Contractor's Material and Test Certificate for Aboveground Piping."

1.5 SUPPLEMENTAL ENGINEERING SERVICES

- A. In the event that the Designer is required to provide additional services as a result of Contractor errors, omissions or failure to conform to the requirements of the Contract Documents, or if the Designer is required to examine and evaluate any changes proposed by the Contractor solely for the convenience of the Contractor, then the Designer's expenses in connection with such additional services shall be paid by the Contractor and shall be deducted from any monies owed to the Contractor or billed separately, solely at the discretion of the Designer. Billable rates are the Designers standard rates, up to a maximum of \$150 per man-hour.

1.6 INTERPRETATION OF DOCUMENTS

- A. In the event of inconsistencies or conflict within or between the Contract Documents, provide the better quality, more costly or greater quantity of Work and comply with the more stringent requirements. Seek the direction of the Architect, Engineer or Designer for clarification of conflicts as soon as a conflict is identified.

1.7 ELECTRONIC FILES

- A. Drawings for this project were prepared using AutoCAD software. Electronic files are available upon request for use by the successful contractor(s) for planning, coordination and installation.
- B. There will be no charge for drawing files that were prepared using AutoCAD. These files will be available in the version in which they were created.
- C. The Request Drawings form can be accessed, filled out and submitted at the following internet address (scroll down to bottom of home page): <http://www.klhengrs.com>.

1.8 QUALITY ASSURANCE

- A. General: Refer to Division 1 Sections for general administrative/procedural requirements related to compliance with codes and standards.

- B. Application: It is a general requirement that mechanical work comply with applicable requirements and recommendations of standards published by listed agencies and trade associations, except to extent more detailed and stringent requirements are indicated or required by governing regulations.
- C. Listing of Associations, Standards and Abbreviations Specific to Fire Suppression Work (in addition to standards specified in individual work sections), conform to following applicable standards:
1. AWS American Welding Society, Inc.
 2. AWWA American Water Works Association, Inc.
 3. EPA Environmental Protection Agency
 4. FM Factory Mutual System
 5. NIST National Institute for Standards and Technology
 6. NEC National Electrical Code by NFPA
 7. NFPA National Fire Protection Association
 8. OSHA Occupational Safety and Health Administration (U.S. Department of Labor)
 9. UL Underwriter's Laboratories, Inc.
- D. Specifications
1. Specifications shall be interpreted in connection with the drawings hereinbefore described, and if anything is shown on drawings and not mentioned in the specifications, or vice versa, it is to be included in the work the same as though clearly set forth by both.
 2. Furthermore, all materials and labor previously required to fully complete the work shall be included in the work even though each item necessarily involved be not specifically mentioned or shown. Such work and/or materials shall be of the same grade and quality as the parts actually specified and shown. Should there be a conflict between the plans and specifications, the greater quantity or better quality shall be furnished.
- E. Plans
1. Plans are diagrammatic indicating required size, points of termination of piping and suggested routes. However, it is not intended that drawings indicate all necessary offsets. Install piping in such manner as to conform to the structure, avoid obstructions and preserve headroom.
 2. Coordination Drawings: Provide coordination drawings and attend meetings as required to make sure all disciplines are coordinated and fit into specified spaces (i.e. ceilings, chases, and all others). The elevations of all disciplines shall be clearly marked throughout the drawings so that no interferences occur. Drawings shall depict actual clearances of installed equipment, penetration locations and service clearances. Indicate scheduling, sequencing, movement and positioning of large equipment during construction. Indicate where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the work. Conflicts in equipment and materials shall be corrected prior to installation.
 3. All piping shall be run as straight as possible and symmetrical with architectural items.
 4. Piping shall be concealed in pipe shafts, pipe spaces, and furring wherever possible.
 5. Piping fabricated before coordination with the other trades will be done at one's own risk.

- F. Installer's Qualifications: Firm with at least three (3) years of successful installation experience on projects with work similar to this project and meet applicable regulatory agencies requirements.
- G. Compatibility: Provide products which are compatible with other products of the mechanical work, and with other work requiring interface with the mechanical work. Provide products with the proper and correct power characteristics, fuel-burning characteristics and similar adaptations for this project. Coordinate the selections from among options (if any) for compatibility of products.
- H. Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. Additional costs to other contractors as a result of providing equipment with higher electrical characteristics shall be the responsibility of the contractor making the substitution. If minimum energy ratings or efficiencies are specified, equipment shall comply with those requirements.

1.9 PERFORMANCE QUALIFICATIONS

- A. Installer's Qualifications: Firm with at least five (5) years of successful installation experience on projects with work similar to this project and meet applicable regulatory agencies requirements.
- B. Compatibility: Provide products which are compatible with other products of the mechanical work and with other work requiring interface with the mechanical work. Provide products with the proper or correct power characteristics, fuel-burning characteristics and similar adaptations for this project. Coordinate the selections from among options (if any) for compatibility of products.
- C. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.
- D. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- E. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- F. Electrical Characteristics for Fire Protection Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If

minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.10 PERFORMANCE REQUIREMENTS

- A. Examine all Mechanical, Electrical, Architectural, Site and Structural Drawings, and available soil reports. Visit site and become acquainted with all conditions which may affect execution of work.
- B. Provide all work in accordance with State and Local Codes, Regulations and/or Ordinances, and meet approval of authorities having jurisdiction. Provide only new material and as specified.
- C. Furnish to the Owner, with a copy to the Owner a Certificate of Final Approval from governing authority prior to Owner's final acceptance, where applicable.
- D. General Outline: The facilities and systems of the mechanical work include all Division 21 Sections.
- E. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- F. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.11 PERMITS AND FEES

- A. Unless specifically described differently in another front-end specification section, all permits and fees of every nature required in connection with this work shall be obtained and paid for by contractor, including installation fees and similar charges.
- B. Laws and regulations which bear upon or affect the various branches of this work shall be complied with.
- C. All work which laws require to be inspected shall be submitted to the proper public officials for inspections and certificates of final approval must be furnished to the Owner before final acceptance will be given by the Engineer.

1.12 WARRANTY (PERIOD OF CORRECTION)

- A. Where not specifically listed within each specific specification section, products and workmanship shall be covered by the Contractor for a period of (1) year from the date of Substantial Completion.

1. Supplied products with manufacturer's warranties of less than the warranty term shall be extended and warranted by the Contractor for the full specified warranty term.
 2. Supplied products featuring a standard manufacturer's warranty whose term extends beyond the Contract Warranty term shall be facilitated by the Contractor for the full duration and under the terms and conditions of the manufacturer's warranty.
- B. The Warranty supplied shall be a full "System Warranty" that covers workmanship and products and includes coverage of onsite and off-site labor and related personnel transportation and product shipping expenses.
1. During this period, the Contractor shall remedy (at no cost to the Owner) any problem with the system, or any of its related components that is the result of defective materials, equipment settings, workmanship, or loss of programming.
- C. Individual sections of this Division may feature more stringent requirements than those set forth in this Section. The most stringent of these requirements shall apply.
- D. Warranty work shall be performed at the Contractor's expense and to the satisfaction of the Owner.
- E. Incomplete work discovered after assertion of work completion is not subject to the (1) year warranty limit and shall be performed upon discovery over the life of the facility(s).
- F. Response Requirements:
1. During the Warranty Period, the Contractor shall:
 - a. Respond by phone within four (4) business hours of notice by the Owner of a problem, and;
 - b. Supply qualified personnel onsite within one (1) business day to begin remediation of the problem, if the problem cannot be remediated over the phone in less time, and;
 - c. Supply "on-call" emergency response service labor (at the request and authorization of the Owner) at an hourly rate that does not exceed the Contractor's published emergency service rates, or two-times the Contractor's standard hourly rate, whichever is lower.

1.13 RECORD DRAWINGS

- A. Provide and maintain on the work site 1 complete set of Record Drawings for the Division 21 work. Carefully record on this set of drawings all work including fixtures, equipment, piping, fittings, components, etc which is installed differently from that indicated on the Drawings; locate dimensionally from fixed points all buried piping including depths relative to finish floor or finish grade elevations as applicable. The depth shall also be indicated for all plugged wyes, tees and capped lines. Mark all changes of location of piping, fixtures and equipment in accordance with Division 1 Sections.

- B. All existing lines discovered shall be indicated on these Drawings and located dimensionally from fixed points along with depths, if buried.
- C. The Record Drawings shall be continuously kept up-to-date and shall be available for inspection anytime during normal working hours.
- D. At completion of the work, provide two neat and legible reproducible sets of the Record Drawings, which shall be individually signed and dated by the Contractor and Project Supervisor as to their accuracy.
- E. Such drawings shall be submitted to for acceptance and approval to the Owner before a final certificate of acceptance will be issued.

1.14 INTERIM LIFE SAFETY WORK

- A. Provide interim fire protection (sprinkler) work in all demolition and construction areas for full code coverage. Further definition will be provided in field if required.

PART 2 - PRODUCTS

2.1 DIELECTRIC FITTINGS

- A. Dielectric fittings shall be provided where two materials of different types of metal connect or come in contact with each other.

2.2 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Coordinate subparagraph and list below with Part 2 "Manufacturers" Article. Retain "Available" for nonproprietary and delete for semiproprietary specifications.
- C. Manufacturers:
 - 1. Hilti, Inc.
 - 2. B-Line Systems, Inc.; a division of Cooper Industries.
 - 3. ITW Ramset/Red Head.
 - 4. Masterset Fastening Systems, Inc.
 - 5. MKT Fastening, LLC.

6. Powers Fasteners.
7. Empire Fastening, LLC

PART 3 - EXECUTION

3.1 MANUFACTURERS

- A. Provide products from manufacturers regularly engaged in the manufacture of products of quality, types and sizes required; and which have been in satisfactory use of not less than four (4) years in similar service, except as otherwise noted in specific sections of this division.

3.2 COORDINATION OF FIRE-SUPPRESSION WORK

- A. Refer to Division 1 Sections for general coordination requirements applicable to entire work. The contract documents are diagrammatic in showing certain physical relationships which must be established within mechanical work, and in its interface with other work, including utilities, control and electrical work.
- B. Arrange fire suppression work in a neat, well organized manner, with piping and similar services running parallel with primary lines of the building.
- C. Give right-of-way to piping which may slope for drainage.
- D. Locate operating and control equipment properly to provide easy access, and arrange entire fire-suppression work with adequate access for operation and maintenance.
- E. Advise other trades of openings required in their work for the subsequent move-in of large units of fire-suppression work (equipment).

3.3 DAMAGE BY LEAKAGE

- A. The Contractor shall be responsible for damage to the grounds, walks, roads, buildings (including walls, floors and ceilings), piping systems, mechanical and electrical systems (and their related equipment and contents) caused by leakage in the piping systems being installed or having been installed herein. The Contractor shall repair all damage caused at no additional cost to the Owner. All repair work shall be performed as directed by the Owner.

3.4 EMERGENCY REPAIRS

- A. The Owner reserves the right to make emergency repairs as may be required to keep equipment in operation without voiding the Contractor's guarantee bond or relieving the Contractor of his responsibilities.

3.5 PHASING

- A. General: Where the scope of work dictates that the project shall be constructed in phases, all costs shall be included for any temporary work required so that previous phases can be operational while construction is being done to adjacent spaces.

3.6 SUPERVISION AND WORKMANSHIP

- A. Workmanship throughout shall conform to the standards of best practice and all labor employed must be competent to do all the work required.
- B. Furnish the services of an experienced superintendent to be in constant charge of the work at all times.
- C. Quality Assurances: If requested, provide documentation that confirms the ability to perform all work to be included under the contract. Assurance if requested, shall be in the form of a list of past projects of similar size and complexity and a list of six (6) references pertaining to those projects. Failure to demonstrate these quality assurances shall be taken as a statement of inability to perform.
- D. A minimum of five (5) years experience in the installation of fire-suppression systems similar to the systems specified is required.
- E. Core Drilling: Use core drills rather than percussion type equipment for making holes in concrete. All percussion type drilling including hammer drills must be scheduled through owner's representative.
- F. Inspection: Provisions shall be made for owner's representative to make rough-in and open ceiling inspections prior to covering up work.

3.7 LOCATIONS AND INSPECTION OF SITE

- A. The Contractor shall fully familiarize himself regarding any and all peculiarities and limitations of the spaces available for the installation of all work and materials furnished and installed under this Contract. Coordinate with all other trades in advance of the work, requirements for openings, recesses and chases in the walls, partitions, equipment housekeeping pads, framing or openings, requirements for servicing equipment and routing of piping relative to each trade to alleviate conflicts. Should furnishing this information be neglected, delayed or incorrect and additional cutting is required, the cost of it shall be borne by the Contractor. Nothing in this paragraph shall be construed to relieve the Contractor of the responsibility for providing and paying for the required core drillings and openings in existing work.
- B. Diagrammatic indications on the Drawings are:
 - 1. Approximate only.

2. Shown distorted at various locations.
3. Possibly moved for visual clarity.

C. Exact locations shall:

1. Be required for proper installation in available space.
2. Be as required to preserve the required space for the servicing of equipment and components.
3. Avoid interference with Architectural and Structural features and the work of all other trades.
4. Be coordinated with the work of all other trades toward the general purpose of having the work progress rapidly and smoothly with a minimum interference between one trade and another.
5. Preserve headroom and keep openings and passageways clear.
6. Conceal all piping above ceilings, in walls, pipe shafts, pipe spaces and furring whenever possible.

D. Include a neat, orderly arrangement of piping symmetrical to building lines, light and tile patterns and other building elements. Any deviations not shown on the Drawings shall be requested in writing prior to implementation.

3.8 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Protect products against dirt, water, chemical and mechanical damage. Do not install damaged products.
- B. Deliver products to site in factory fabricated containers, with the manufacturer's label clearly visible. Handle carefully to avoid damage to components, enclosure and finish, and in strict accordance with manufacturer's instructions.
- C. Store products in clean dry place in original containers, protected from weather and construction traffic.

3.9 SUBSTITUTIONS

- A. A substitution is the use of any product other than that identified as the "Basis of Design," the "Standard of Quality," or an "Additional Approved Product."
- B. Substitutions require pre-bid approval. Only substitutions authorized via addendum shall be considered.
- C. Substitutions are considered on a product-by-product and model specific basis.
- D. Substitution Submittal Requirements:

1. Substitution requests must be received by the Designer sufficiently in advance of the scheduled bid date to allow time for review and issuance of an Addendum. If the timing of the request does not permit an Addendum, substitution shall not be considered or acceptable.
2. Substitution requests shall consist of the following for each proposed substitution:
 - a. Substitution Request Letter:
 - 1) On company letterhead, for each specific product substitution request. The letter shall include the following:
 - a) The specification section and paragraph number and drawing number where the product requirement is identified.
 - b) The specific system in which the product is to be used.
 - c) The reason the Contractor is requesting the substitution.
 - d) Statement of impact on the system(s) in which the product is used.
 - e) An enumeration declaring each difference between the Basis of Design product and the proposed substitute, including performance differences, technical specifications difference, feature differences, method of operation differences, warranty differences, dimensional differences, method and means of control differences, compliance differences. Failure to disclose 100-percent of the differences in this manner may be grounds for a post-bid and/or post-installation rejection of Contractor proposed substitute product.
 - 2) A separate letter shall be furnished for each product substitution request.
 - b. Product Datasheets/Brochures:
 - 1) Complete system brochure(s) and/or individual product data sheet(s), as applicable and appropriate for the Basis of Design product(s) the requested substitute is intended to replace.
 - 2) Complete system brochure(s) and/or individual product data sheet(s), as applicable, for the proposed substitute product(s).
3. Failure to furnish the required information is sufficient grounds for rejection of the request for substitution.
4. A demonstration of the proposed substitute equipment and/or system(s) may be required by the Designer prior to consideration of substitute products or system(s). Costs associated with these demonstrations are the responsibility of the entity submitting the request.
5. Substitution Pre-Bid Submittal Exceptions:
 - a. Additional Approved Manufacturer(s):
 - 1) These specifications may use phrases such as “or equal by,” or “Additional Approved Manufacture(s)” for products. When a product category uses these designations, it is an indication that a product model from one of the listed manufacturer(s) may be provided without the requirement to obtain pre-bid approval for the model selected, provided that the Contractor has adequately researched and has become familiar with the Basis of Design product and intends to supply a model that is equal to or superior than the Basis of Design product.
 - 2) Since it is impractical to enumerate every characteristic of modern electronic products, it is incumbent upon the Contractor to research manufacturer’s publications to obtain the fullest possible understanding of Basis of Design / Standard of Quality products the Contractor proposes to

- substitute with a product from any Additional Approved Manufacturer considered.
- 3) Although not mandatory, for the Contractor's own protection, model specific pre-bid approval is strongly encouraged.
 - 4) The decision as to whether a Contractor selected model from a list of Approved Additional Manufacturer(s) is acceptable remains solely with the Designer, and the Designer's decision is final.
- E. Costs that result from the use of substitute products and/or Additional Approved Manufacturer(s), including costs for additional equipment, coordination, accessories, modules, interface products, cables, software, and programming, as well as costs for any additional labor, materials, and products incurred by other trades or members of the project Design Team or Owner, are the sole responsibility of the Contractor making the substitution. This includes costs that may not be incurred or known until after Contract award or Work execution. Such costs shall be deducted from final sum payable to the Contractor.
- F. Post Contract award substitutions may be considered, but only if the proposed substitution includes substantial additional benefit to the Owner. Post award substitutions are considered solely at the discretion and convenience of the Designer. For a post Contract award substitution to be considered, one or more of the following shall apply:
1. The Designer initiates the request for substitution.
 2. A basis of design product has become discontinued and is no longer available, and as a result, the use of a substitute product has become a necessity to meet the Owner's objectives for the Project. See "Discontinued Products."
 3. The request for substitution is accompanied by a proposal that identifies the benefits to the Owner, including a fair-market Contract price reduction.

3.10 EXPLANATION AND PRECEDENCE OF DRAWINGS AND SPECIFICATIONS

- A. Prior to submitting his bid, the Contractor shall review all Drawings and Specifications to determine any conflict with all applicable local codes, rules or regulations. The Contractor shall obtain clarification of such during bidding.
- B. When the work as indicated on the Drawings and/or Specifications exceeds the minimum required by any code, standard, rule or regulation, the Drawings and/or Specifications shall govern the design and installation of the work.
- C. For purposes of clarity and legibility, the Drawings are essentially diagrammatic although size and location of equipment are drawn to scale wherever possible. The Contractor shall make use of and verify all information on the Drawings and Specifications.
- D. The Contractor shall fully inform himself regarding any and all peculiarities and limitations of the spaces available for the installation of all work and materials furnish and installed under this Contract. He shall exercise due and particular caution to determine that all parts of his work are made readily accessible.

- E. The Drawings indicate required sizes and points of termination of piping and suggests proper routes to conform to structure, avoid obstructions and preserve clearances. However, it is not intended that the Drawings indicate all necessary offsets, and it shall be the work of the Contractor to make the installation in such a manner as to conform to the structure, avoid obstructions, preserve headroom, keep openings and passageways clear and maintain required service clearances without additional cost to the Owner.
- F. Significant changes by the Contractor in design, sizing and/or location of system piping, fixtures and/or equipment as shown on the Drawings are prohibited without prior written approval by the Owner. Should the Contractor fail to obtain the Owner's written approval and proceed to make these unauthorized changes, he does so at the risk of accepting total responsibility and related costs therein for the design elements he may alter.
- G. It is intended that all fire protection devices, piping, etc. be located symmetrically with all Architectural elements. Refer to the Drawings and Specifications of all disciplines in completing the required coordination.
- H. Where the Drawings and/or Specifications are in conflict, obtain clarification of such during bidding. Official clarification will only be given in written form. Any clarification issued by other than written form will not be considered official and shall be non-binding for work under this Contract. Where clarification cannot be delivered in a timely manner, the Contractor shall base his bid on the greater quantities, higher standards or more restrictive requirements. In the event of discrepancies in the Drawings and/or Specifications after the bid period, the Contractor shall advise the Architect and Engineer of such prior to proceeding with the work in question in order that correct progress of the work may be insured.
- I. Prior to submitting his bid, the Contractor shall review all Drawings and Specifications to determine any conflict with all applicable local codes, rules or regulations. The Contractor shall obtain clarification of such during bidding as outlined above.
- J. The submittal of his bid shall indicate the Contractor has examined the site; all applicable local codes, rules and regulations; the Drawings and Specifications and has included all required allowances in his bid. No allowance shall be made for any error or omission resulting from the Contractor's failure to visit the job site and/or review the Drawings and Specifications. The Contractor's bid shall include costs for all required drawings and changes as outlined above at no additional cost to the Owner.

3.11 CUTTING, PATCHING, AND DEMOLITION

- A. Refer to Division 1 Sections "Cutting and Patching" and "Selective Demolition" for general demolition requirements and procedures.
- B. Contractor shall include all necessary cutting and patching required to perform their work. For interior work, cut and patch all walls, ceilings, and floors as applicable. For exterior work, provide saw-cutting, replacement of concrete, paving, re-seeding/straw for grassy areas, and replacement of landscaping areas where applicable.

- C. All cutting of concrete work by the Contractor shall be by core drilling or concrete saws with dust collection systems. No cutting or coring of structural members shall be done without first obtaining the permission of the Owner. All cuts by the Contractor shall be plumb, square and true.
- D. Core Drilling: Use core drills rather than percussion type equipment for making holes in concrete. All percussion type drilling including hammer drills must be scheduled through the Owner.
- E. All patching of existing, adjacent surfaces shall match existing material and finish in a manner satisfactory to the Architect.
- F. Disconnect, demolish, and remove fire protection systems, equipment, and components indicated to be removed and as necessary to perform the described scope of work.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- G. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
- H. No means of demolition shall be used that would result in damage to structures, materials, equipment or components indicated to remain or endanger the health, safety and welfare of the general public. The use of explosives is strictly prohibited. Where piping, insulation, fixtures, equipment or components to remain are damaged or disturbed, remove damaged portions and install new products of equal capacity and quality, subject to the approval of and at no additional cost to the Owner.
- I. Demolition Scope of Work:
 - 1. Before beginning demolition, make all arrangements required to turn off and disconnect utilities and other such facilities involved.
 - 2. The Owner has the right of first refusal of all removed materials as indicated on the Drawings. All items designated to remain as the Owner's property shall be removed, cleaned and presented to him as he may direct.
 - 3. All items to be removed and relocated shall be removed and responsibly stored, cleaned, repaired (as required and to satisfactory working order), reinstalled (complete with new fittings, trim, etc), reconnected and made operational by the Contractor.

4. All other demolished items shall become property of the Contractor and shall be responsibly disposed of in accordance with applicable codes and regulations or salvaged. All costs associated with disposal or salvaging are the Contractor's responsibility.

3.12 SYSTEM TESTS

- A. Perform all system tests in the presence of an authorized representative of the Owner and local authority having jurisdiction as applicable. Notify the Owner of all system's tests at least 48 hours in advance.

3.13 EXCAVATING AND BACKFILLING

- A. Refer to the site utility specifications for additional requirements for exterior piping excavation and backfilling.
- B. Comply with all codes in jurisdiction. Provide slope sides, shore and brace as required for stability.
- C. Perform all excavation and backfilling required for his work and shall consult with utilities prior to beginning excavation.
- D. Remove materials of every nature and description encountered in obtaining indicated lines and grades as shown on drawings. No extras will be allowed due to variations of proportion and the variation of materials.
- E. At a minimum, all piping shall be laid on a bed of sand, 6" deep, well tamped into place and properly graded to permit the pipe to have an even bearing throughout its entire length. Sand shall be installed around the piping and to a point 6" above the piping.
- F. Excess excavated earth materials shall be removed from the site.
- G. All backfilling above piping shall be flowable fill or bankrun gravel with clay compaction above to the subbase.
- H. All backfilling under pavement and sidewalks shall be flowable fill up to paving base/subbase material(s). All excavations shall be compacted to prevent settling.
 1. Roadways, walks and slabs 100%
 2. Yard areas 95%
- I. Compaction shall be performed in 12" lifts and spread evenly.
- J. Pay for all expenses for the proper restoration of all streets, sidewalks, concrete and blacktop surfaces broken for installing piping.

3.14 CLEANING PREMISES

- A. During the progress of the work, clean up and leave the premises and all portions of the building in which work was performed in a clean and safe condition. Refer to Division 1.
- B. Dispose of construction waste in accordance with Division 01 section "Construction Waste Management and Disposal".

3.15 MAINTENANCE, OPERATION INSTRUCTIONS, ETC.

- A. General: Before final acceptance of the project by the Owner, the Contractor shall schedule with the Owner's maintenance personnel, at a time mutually convenient, a training session. At this time, he will thoroughly familiarize the Owner's maintenance personnel with all operating and service procedures (routine and emergency) associated with the building systems and equipment. Provide the Owner with two hard copies of a list of all equipment including the following information:
 - 1. Manufacturer's name.
 - 2. Equipment model number
 - 3. Equipment serial number.
 - 4. Local sales representative (including postal & email addresses and telephone & fax numbers).
 - 5. Parts list, complete with source(s) of supply.
 - 6. Complete internal wiring diagrams.
 - 7. Warranties.
- B. All directions for operation furnished by the manufacturer shall be carefully saved and turned over to the Owner, together with written sequence of operation, operating and maintenance schedules & instructions (routine and emergency) for each system and its equipment. All verbiage and units of measure shall be in English.

3.16 PROJECT SITE SAFETY

- A. The Engineer claims no expertise in and assumes no responsibility for any and all safety procedures and protocols associated with the Contractor's work. The Contractor shall exercise due diligence and comply with all established safety standards and regulations as listed by OSHA and any equipment manufacturers' requirements as they may relate to personal safety. The Contractor shall insure that all of his subcontractor(s) and/or tradesmen are apprised of all safety-related standards and procedures as they may relate to their work and immediately correct any violation of OSHA standards and regulations or equipment manufacturers' safety recommendations.

3.17 WORK IN EXISTING SPACES

- A. General: Care shall be taken when working in existing spaces so as not to damage existing walls and ceilings where work is being performed.

- B. Existing Ceilings: Where work is being performed above ceilings, and the architectural drawings do not indicate ceiling modifications are the responsibility of others, remove and replace existing ceilings where work is being performed. In those instances, costs for all repair and installation of new grid, ceiling panels, etc shall be included. Match existing finishes.
- C. New Ceilings: Where existing sprinklers are to remain, and the architectural drawings indicate replacement of the ceilings, temporarily remove and reinstall sprinkler escutcheons, etc. as required to accommodate the ceiling removal.
- D. Walls & Floors: Patch existing walls and floors and match existing finishes where work is being removed or installed and patching is being performed, unless noted otherwise on the architectural drawings.

3.18 FIRE ALARM RELATED WORK FOR FIRE-SUPPRESSION SYSTEMS

- A. The following applies whether or not shown on drawings. Prior to submitting a bid, review documents of all other disciplines which may have an impact on such work.
- B. If a sprinkler system exists in the building, furnish and install all required flow and tamper switches. Wiring and installation of the fire alarm devices shall not be included.

3.19 ARCHITECTURAL COORDINATION ITEMS

- A. Cut and drill all openings in walls and floors required for the installation. Secure approval of Engineer before cutting and drilling. Neatly patch all openings cut.
- B. Cutting and patching to be held to a minimum. Coordinate locations of sleeves and openings before construction is started.
- C. Patching through fire rated walls and enclosures shall not diminish the rating of that wall or enclosure. Patch shall be equal to rockwool, firestop, caulk or approved "rated" patch.
- D. Caulk or fire safe between sleeves and pipes, see Division 7 for caulking and fire-safing requirements and the floor plan and partition schedule for partition ratings.
- E. Furnish all access panels required for proper servicing of equipment. Provide access panels for all concealed valves, controls, and sprinkler devices required by NFPA. Provide frame as required for finish. Exact locations to be approved by the Architect. Minimum size to be 12" x 12", units to be 16 gauge steel, locking device shall be screwdriver cam locks. Refer to Division 9 for access panel manufacturers and material requirements. Provide phenolic plate with ID of item behind access panel on the face of the door.
- F. Install steel pipe sleeves two sizes larger than pipes passing through floors, walls or masonry construction.

- G. Sleeves through walls to be cut flush with both faces.
- H. Sleeves through floor to extend one inch above floor top elevation.
- I. Caulk or fire safe between sleeves and pipes, see Division 7 for caulking and fire-safing requirements and the floor plan partition schedule for partition ratings.
- J. Install manufactured chromium plated escutcheon plates wherever uninsulated exposed pipes pass through walls, floors, or ceilings. Escutcheon inside diameter to closely fit around pipe and outside diameter to completely cover opening.
- K. Furnish and set all forms required in masonry walls or foundation to accommodate pipes.
- L. Provide flexible connectors where all pipes cross building expansion joints. Coordinate exact quantity & location with Architectural plans prior to installation of piping.

END OF SECTION 210500

SECTION 210517 - SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION

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. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Mechanical Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.

1.3 SUBMITTALS

- A. General:
 - 1. Comply with Section 21 05 03.00 "Submittals for Fire-Suppression."
- B. Product Data (PD):
 - 1. Product Datasheets for Sleeve Seals.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Galvanized-steel Sheet: 0.0239 inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Install steel pipe sleeves two sizes larger than pipes passing through floors, walls or masonry construction.

2.2 STACK-SLEEVE FITTINGS

- A. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
1. Underdeck Clamp: Clamping ring with setscrews.

2.3 MECHANICAL SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Advance Products & Systems, Inc.
 2. CALPICO, Inc.
 3. Metraflex Company (The).
 4. Pipeline Seal and Insulator, Inc.
 5. Proco Products, Inc.
 6. Link-Seal Modular Seals
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 2. Pressure Plates: Carbon steel.
 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Presealed Systems.
 2. Advance Products & Systems, Inc.
 3. CALPICO, Inc.
 4. Metraflex Company (The).
 5. Pipeline Seal and Insulator, Inc.
 6. Proco Products, Inc.
 7. Link-Seal Modular Seals
- B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, nonshrink, and recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- B. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- C. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."
- D. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
- B. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
- C. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
- D. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
- E. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
- F. Using grout, seal the space around outside of stack-sleeve fittings.
- G. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
1. Exterior Concrete Walls above Grade:
 - a. Galvanized-steel-pipe sleeves.
 2. Exterior Concrete Walls below Grade:
 - a. Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 3. Concrete Slabs-on-Grade:
 - a. Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 4. Concrete Slabs above Grade:
 - a. Stack-sleeve fittings
 - b. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
 5. Interior Partitions:
 - a. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

END OF SECTION 210517

SECTION 210518 - ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

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. Escutcheons.
 - 2. Floor plates.

1.3 SUBMITTALS

- A. General:
 - 1. Comply with Section 21 05 03.00 "Submittals for Fire-Suppression."

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with rough-brass finish.
 - f. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with rough-brass finish.
 - 2. Escutcheons for Existing Piping:
 - a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
 - b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - c. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - d. Bare Piping in Unfinished Service Spaces: Split-casting brass type with rough-brass finish.
 - e. Bare Piping in Equipment Rooms: Split-casting brass type with rough-brass finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor-plate type.
 - 2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 210518

SECTION 211316 - DRY-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Fire-protection valves.
 - 3. Fire-department connections.
 - 4. Sprinklers.
 - 5. Alarm devices.
 - 6. Pressure gages.

1.3 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Dry-pipe sprinkler system piping designed to operate at working pressure of 175 psig maximum.

1.4 SYSTEM DESCRIPTIONS

- A. Dry-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing compressed air. Opening of sprinklers releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into piping and discharges from sprinklers that are open.

1.5 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - 1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 - 2. Sprinkler Occupancy Hazard Classifications:
 - a. Office and Public Areas: Light Hazard.
 - b. Building Service Areas: Ordinary Hazard, Group
 - c. Electrical Equipment Rooms: Ordinary Hazard, Group 1.

- d. General Storage Areas: Ordinary Hazard, Group 1.
- e. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
3. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
 - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
4. Maximum Protection Area per Sprinkler: Per UL listing.
5. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:
 - a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
 - b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.

1.6 SUBMITTALS

A. General:

1. Comply with Section 21 05 03.00 "Submittals for Fire-Suppression."

B. Product Data (PD):

1. Provide product datasheets for all fire-suppression materials, components, valves, devices, and equipment. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories

C. Shop Drawings (SD), Delegated-Design Submittal: For fire-suppression systems in compliance with performance requirements and design criteria, all applicable codes, the authority having jurisdiction, and NFPA guidelines. Shop Drawings and associated hydraulic calculations shall be signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include plans, elevations, sections, and attachment details.
2. Include water flow test data and calculations on the drawings.
3. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - a. Items penetrating finished ceiling include the following:
 - 1) Lighting fixtures.
 - 2) Air outlets and inlets.
 - b. Coordinate with all equipment, piping, conduit, ductwork, from other contractors.

D. Closeout Submittals (CO):

1. Provide 2 hard copies of operation and maintenance manuals for all fire-suppression components, valves, devices, and equipment.
2. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA. Include "Contractor's Material and Test Certificate for Aboveground Piping."

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems."
2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."
3. NFPA No. 70 - National Electrical Code
4. NFPA No. 72 - National Fire Alarm Code
5. FM Approvals
6. Underwriters Laboratory
7. Requirements of the Authority Having Jurisdiction (AHJ)

1.8 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.9 EXTRA MATERIALS

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

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.2 STEEL PIPE AND FITTINGS

- A. All piping and fittings shall be galvanized.
- B. Piping 2" and smaller shall be Standard Weight, Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
- C. Piping 2-1/2" and larger shall be Schedule 10, Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.
- D. Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- E. Steel Couplings: ASTM A 865, threaded.
- F. Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- G. Malleable- or Ductile-Iron Unions: UL 860.
- H. Cast-Iron Flanges: ASME 16.1, Class 125.
- I. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- J. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
- K. Grooved-Joint, Steel-Pipe Appurtenances:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Anvil International, Inc.
 - b. Corcoran Piping System Co.
 - c. National Fittings, Inc.
 - d. Shurjoint Piping Products.
 - e. Tyco Fire & Building Products LP.
 - f. Victaulic Company.

2. Pressure Rating: 175 psig minimum.
3. Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts. Fittings in paragraph below are available in NPS 3/4 to NPS 2 (DN 20 to DN 50).

- L. Steel Pressure-Seal Fittings: UL 213, FM-approved, 175-psig pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.

2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.
1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
 2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

2.4 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
1. Valves shall be UL listed or FM approved.
 2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig.

2.5 TRIM AND DRAIN VALVES

- A. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 2. Pressure Rating: 175 psig minimum.

2.6 SPECIALTY VALVES

- A. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 2. Pressure Rating:
 - a. Standard-Pressure Piping Specialty Valves: 175 psig.

3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Dry-Pipe Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Globe Fire Sprinkler Corporation.
 - b. Reliable Automatic Sprinkler Co., Inc.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.
 - e. Viking Corporation.
2. Standard: UL 260
3. Design: Differential-pressure type.
4. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
5. Air Compressor:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Gast Manufacturing Inc.
 - 2) General Air Products, Inc,
 - 3) Viking Corporation.
 - b. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.

C. Automatic (Ball Drip) Drain Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AFAC Inc.
 - b. Reliable Automatic Sprinkler Co., Inc.
 - c. Tyco Fire & Building Products LP.
2. Standard: UL 1726.
3. Pressure Rating: 175 psig minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4.
6. End Connections: Threaded.

2.7 FIRE-DEPARTMENT CONNECTIONS

A. Yard-Type, Fire-Department Connection:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AFAC Inc.
 - b. Elkhart Brass Mfg. Company, Inc.
 - c. Fire-End & Croker Corporation.
 - d. Fire Protection Products, Inc.
 - e. GMR International Equipment Corporation.
 - f. Guardian Fire Equipment, Inc.
 - g. Wilson & Cousins Inc.
2. Standard: UL 405.
3. Type: Exposed, freestanding.
4. Pressure Rating: 175 psig minimum.
5. Body Material: Corrosion-resistant metal.
6. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
7. Caps: Brass, lugged type, with gasket and chain.
8. Escutcheon Plate: Round, brass, floor type.
9. Outlet: Bottom, with pipe threads.
10. Sleeve: Brass.
11. Sleeve Height: 18 inches.
12. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE" or "AUTO SPKR" (as applicable).
13. Finish, Including Sleeve: Polished chrome plated.

2.8 SPRINKLERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Globe Fire Sprinkler Corporation.
 2. Reliable Automatic Sprinkler Co., Inc.
 3. Tyco Fire & Building Products LP.
 4. Victaulic Company.
 5. Viking Corporation.
- B. General Requirements:
 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 2. Pressure Rating for Residential Sprinklers: 175 psig maximum.
 3. Pressure Rating for Automatic Sprinklers: 175 psig minimum.
 4. Pressure Rating for High-Pressure Automatic Sprinklers: 300 psig.
- C. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
 2. Nonresidential Applications: UL 199.
 3. Residential Applications: UL 1626.
 4. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- D. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
1. Ceiling Mounting: Chrome-plated steel, one piece, flat, with 1-inch vertical adjustment.
 2. Sidewall Mounting: Chrome-plated steel, one piece, flat.
- E. Sprinkler Guards:
1. Provide sprinkler guards to protect exposed sprinklers in mechanical rooms, in gymnasiums, and all other locations subject to damage.
 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - d. Viking Corporation.
 3. Standard: UL 199.
 4. Type: Wire cage with fastening device for attaching to sprinkler.

2.9 ADDITIONAL SPRINKLERS

- A. For each type of sprinkler being used, provide and maintain a minimum of four spare sprinklers on the premises during construction so that any sprinklers that have operated or been damaged in any way can be promptly replaced.
- B. For each type of sprinkler being used, provide the owner with a minimum of six additional sprinklers in a wall mounted storage cabinet. Coordinate location of storage cabinet with owner.
- C. Where dry sprinklers of different lengths are installed, spare dry sprinklers shall not be required, provided that a means of returning the system to service is furnished.
- D. Furnish and install a sprinkler head storage cabinet(s) large enough to house all of the spare sprinklers and tools. Install the cabinet where the temperature to which they are subject will at no time exceed 100 F.

- E. A special sprinkler wrench shall be provided and kept in the cabinet to be used in the removal and installation of sprinklers. One sprinkler wrench shall be provided for each type of sprinkler installed.

2.10 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Water-Motor-Operated Alarm:
 - 1. Standard: UL 753.
 - 2. Type: Mechanically operated, with Pelton wheel.
 - 3. Alarm Gong: Cast aluminum with red-enamel factory finish.
 - 4. Size: 10-inch diameter.
 - 5. Components: Shaft length, bearings, and sleeve to suit wall construction.
 - 6. Inlet: NPS 3/4.
 - 7. Outlet: NPS 1 drain connection.
- C. Pressure Switches:
 - 1. Standard: UL 346.
 - 2. Type: Electrically supervised water-flow switch with retard feature.
 - 3. Components: Single-pole, double-throw switch with normally closed contacts.
 - 4. Design Operation: Rising pressure signals water flow.
- D. Valve Supervisory Switches:
 - 1. Standard: UL 346.
 - 2. Type: Electrically supervised.
 - 3. Components: Single-pole, double-throw switch with normally closed contacts.
 - 4. Design: Signals that controlled valve is in other than fully open position.
- E. Indicator-Post Supervisory Switches:
 - 1. Standard: UL 346.
 - 2. Type: Electrically supervised.
 - 3. Components: Single-pole, double-throw switch with normally closed contacts.
 - 4. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.11 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering Standard: UL 393.
- B. Dial Size: 3-1/2- to 4-1/2-inch diameter.

- C. Pressure Gage Range: 0 to 300 psig.
- D. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.
- E. Air System Piping Gage: Include retard feature and "AIR" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

- A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Section 211100 "Facility Fire-Suppression Water-Service Piping."

3.3 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

- G. Install sprinkler piping with drains for complete system drainage.
- H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- I. Install automatic (ball drip) drain valves to drain piping between fire-department connections and check valves. Drain to floor drain or to outside building.
- J. Connect air compressor to the following piping and wiring:
 - 1. Pressure gages and controls.
 - 2. Electrical power system.
 - 3. Fire-alarm devices, including low-pressure alarm.
- K. Install alarm devices in piping systems.
- L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements in NFPA 13 for hanger materials.
- M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- N. Drain dry-pipe sprinkler piping.
- O. Pressurize and check dry-pipe sprinkler system piping and air-pressure maintenance devices and air compressors.
- P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.4 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- I. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.5 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 - 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
 - 2. Dry-Pipe Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
 - a. Install air compressor and compressed-air supply piping.

3.6 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings within 1 inch in both directions, in the center of a 2x2 ceiling tile or in the center of a 2x2 end-section of a 2x4 ceiling tile.
- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

3.7 FIRE-DEPARTMENT CONNECTION INSTALLATION

- A. Install yard-type, fire-department connections in concrete slab support. Comply with requirements for concrete in Section 033000 "Cast-in-Place Concrete."
 - 1. Where not protected from vehicular traffic with curbing, install protective pipe bollards on two sides of each fire-department connection. Comply with requirements for bollards in Section 055000 "Metal Fabrications."
- B. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

3.8 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Start and run air compressors.
6. Coordinate with fire-alarm tests. Operate as required.
7. Coordinate with fire-pump tests. Operate as required.
8. Verify that equipment hose threads are same as local fire-department equipment.

C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.10 CLEANING

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.12 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers with rough bronze finish or horizontal sidewall sprinklers with rough bronze finish.
2. Finished Rooms with Ceilings:
 - a. Ceilings: Recessed pendent sprinklers with factory-painted white finish on sprinkler and adjustable escutcheon.
 - b. Walls: Exposed horizontal sidewall sprinklers with bronze finish.

END OF SECTION 211316

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. All products and materials used in association with the scope of work defined in these documents shall be in compliance with the 2009 American Recovery and Reinvestment Act (ARRA). Refer to front end specifications for more information. All equipment submittals shall include a signed/dated letter from the manufacturer indicating their certification of compliance with the Made in America provisions and requirements of the ARRA.

1.2 SUMMARY

- A. Section includes general requirements for plumbing systems.
- B. Examine the drawings, specifications, and visit the site prior to submitting a bid.
- C. The base bid shall include furnishing all materials, labor, tools, equipment and installation of all work required to install complete plumbing systems as outlined in Division-22.
- D. Unless specifically described otherwise, the contractor responsible for installing the work inside the building shall extend all plumbing utilities from a point 5'-0" outside the building.
- E. Products and Topics in this Section Include:
 - 1. Definitions.
 - 2. Submittals.
 - 3. Supplemental Engineering Services.
 - 4. Interpretation of Documents.
 - 5. Electronic Files.
 - 6. Quality Assurance.
 - 7. Performance Qualifications.
 - 8. Performance Requirements.
 - 9. Permits and Fees.
 - 10. Record Drawings.
 - 11. Dielectric fittings.
 - 12. Fastener systems.
 - 13. Flowable Fill - Controlled Low Strength Material.
 - 14. Manufacturers.
 - 15. Coordination of Plumbing Work.
 - 16. Interruption of Utilities.

17. Damage by Leakage.
18. Emergency Repairs.
19. Phasing.
20. Supervision and Workmanship.
21. Locations and Inspection Of Site
22. Product Delivery, Storage, and Handling.
23. Substitutions.
24. Explanation and Precedence of Drawings and Specifications
25. Cutting, Patching, and Demolition.
26. System Tests.
27. Excavating and Backfilling.
28. Cleaning Premises.
29. Maintenance, Operation Instructions, Etc.
30. Project Site Safety
31. Work in Existing Spaces.
32. Architectural Coordination Items

1.3 DEFINITIONS

- A. Acceptance Testing Authorities (ATA): The individuals and/or business entities that participate in Acceptance Testing and report to the Owner when work appears to be complete. These parties represent the interest of the Owner.
- B. Authority Having Jurisdiction (AHJ): The governmental agency or sub-agency having authority over the construction process and having the ultimate authority to enforce, uphold and rule on codes and safety compliance at the project site.
- C. Contractor: The entity(s) contractually responsible for performing work of this Division.
- D. Wherever the words "Site," "Project Site," or "Premises" appear in these specifications or related drawings, it shall be interpreted to mean real estate, buildings and structures where work shall be performed and where products shall be installed and reside.
- E. Commissioning Authority: An agent of the Owner, often independent of the design team, responsible for ensuring compliance with the Owner's project intent. The commissioning authority represents the interest of the Owner.
- F. Contractor of Record: A business entity entering into a contract for any element of work defined in the Project Documents directly with the Owner, directly with the Construction Manager or directly with a General Contractor.
- G. Designer: The Consultant(s) representing the Owner and directly responsible for specification of work within this Division, including related drawings. The Designer may or may not be affiliated with the architectural or an engineering firm of record for the Project. The Designer is a member of the project Design Team.

- H. **Furnish:** To supply product or labor (context dependent) including associated shipping, storage, travel, lodging, miscellaneous and warranty expenses.
- I. **Install:** To supply labor, tools and incidental materials necessary to handle, store, mount, terminate, program, configure and adjust a product in order to fulfill the requirements of the Project.
- J. **Provide:** To furnish and install, inclusive of accessories, modules, and ancillary items necessary to render the respective product and system fully operational and usable to the Owner for the intended purpose.
- K. **Substantial Completion Division 21 only:**
 - 1. The point in the Project where work of this Division that occurs at the project site has been completed. For work to be substantially complete, the following must be valid:
 - a. Products have been delivered and installed at the project site, and;
 - b. Systems have been installed, tested, adjusted and are operational for their intended purpose, and;
 - c. Products have been labeled in accordance with the Contract Documents, and;
 - d. Systems are performing in accordance with the design intent, and;
 - e. Systems have been demonstrated to the Owner as complete and working.
- L. **Supply:** Used interchangeably with “furnish.” See “Furnish.”
- M. **This Division:** This Section and each specification section beginning with the same two digit number.
- N. **Work:** The supply of products, materials, labor, incidentals and services necessary to fulfill the requirements of the Project.

1.4 SUBMITTALS

- A. Comply with requirements of Section 22 05 03 “Submittals for Plumbing.”
- B. **General:**
 - 1. Comply with Section 22 05 03.00 “Submittals for Plumbing.”
- C. **Product Data (PD):**
 - 1. Provide product datasheets for all plumbing materials, components, fixtures, valves, and equipment.
- D. **Closeout Submittals (CO):**

1. Provide operation and maintenance manuals for all plumbing components, fixtures, valves, and equipment.

1.5 SUPPLEMENTAL ENGINEERING SERVICES

- A. In the event that the Designer is required to provide additional services as a result of Contractor errors, omissions or failure to conform to the requirements of the Contract Documents, or if the Designer is required to examine and evaluate any changes proposed by the Contractor solely for the convenience of the Contractor, then the Designer's expenses in connection with such additional services shall be paid by the Contractor and shall be deducted from any monies owed to the Contractor or billed separately, solely at the discretion of the Designer. Billable rates are the Designers standard rates, up to a maximum of \$150 per man-hour.

1.6 INTERPRETATION OF DOCUMENTS

- A. In the event of inconsistencies or conflict within or between the Contract Documents, provide the better quality, more costly or greater quantity of Work and comply with the more stringent requirements. Seek the direction of the Architect, Engineer or Designer for clarification of conflicts as soon as a conflict is identified.

1.7 ELECTRONIC FILES

- A. Drawings for this project were prepared using AutoCAD software. Electronic files are available upon request for use by the successful contractor(s) for planning, coordination and installation.
- B. There will be no charge for drawing files that were prepared using AutoCAD. These files will be available in the version in which they were created.
- C. The Request Drawings form can be accessed, filled out and submitted at the following internet address (scroll down to bottom of home page): <http://www.klhengrs.com>.

1.8 QUALITY ASSURANCE

- A. General: Refer to Division 1 Sections for general administrative/procedural requirements related to compliance with codes and standards.
- B. Application: It is a general requirement that mechanical work comply with applicable requirements and recommendations of standards published by listed agencies and trade associations, except to extent more detailed and stringent requirements are indicated or required by governing regulations.
- C. Listing of Associations, Standards and Abbreviations Specific to Plumbing Work (in addition to standards specified in individual work sections), conform to following applicable standards:
 1. AWS American Welding Society, Inc.

2. AWWA American Water Works Association, Inc.
3. EPA Environmental Protection Agency
4. NIST National Institute for Standards and Technology
5. NEC National Electrical Code by NFPA
6. NFPA National Fire Protection Association
7. OSHA Occupational Safety and Health Administration (U.S. Department of Labor)
8. UL Underwriter's Laboratories, Inc.

D. Specifications

1. Specifications shall be interpreted in connection with the drawings hereinbefore described, and if anything is shown on drawings and not mentioned in the specifications, or vice versa, it is to be included in the work the same as though clearly set forth by both.
2. Furthermore, all materials and labor previously required to fully complete the work shall be included in the work even though each item necessarily involved be not specifically mentioned or shown. Such work and/or materials shall be of the same grade and quality as the parts actually specified and shown. Should there be a conflict between the plans and specifications, the greater quantity or better quality shall be furnished.

E. Plans

1. Plans are diagrammatic indicating required size, points of termination of piping and suggested routes. However, it is not intended that drawings indicate all necessary offsets. Install piping in such manner as to conform to the structure, avoid obstructions and preserve headroom.
2. Coordination Drawings: Provide coordination drawings and attend meetings as required to make sure all disciplines are coordinated and fit into specified spaces (i.e. ceilings, chases, and all others). The elevations of all disciplines shall be clearly marked throughout the drawings so that no interferences occur. Drawings shall depict actual clearances of installed equipment, penetration locations and service clearances. Indicate scheduling, sequencing, movement and positioning of large equipment during construction. Indicate where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the work. Conflicts in equipment and materials shall be corrected prior to installation.
3. All piping shall be run as straight as possible and symmetrical with architectural items.
4. Piping shall be concealed in pipe shafts, pipe spaces, and furring wherever possible.
5. Piping fabricated before coordination with the other trades will be done at one's own risk.

F. Installer's Qualifications: Firm with at least three (3) years of successful installation experience on projects with work similar to this project and meet applicable regulatory agencies requirements.

G. Compatibility: Provide products which are compatible with other products of the mechanical work, and with other work requiring interface with the mechanical work. Provide products with the proper and correct power characteristics, fuel-burning characteristics and similar adaptations for this project. Coordinate the selections from among options (if any) for compatibility of products.

- H. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. Additional costs to other contractors as a result of providing equipment with higher electrical characteristics shall be the responsibility of the contractor making the substitution. If minimum energy ratings or efficiencies are specified, equipment shall comply with those requirements.

1.9 PERFORMANCE QUALIFICATIONS

- A. Installer's Qualifications: Firm with at least five (5) years of successful installation experience on projects with work similar to this project and meet applicable regulatory agencies requirements.
- B. Compatibility: Provide products which are compatible with other products of the mechanical work and with other work requiring interface with the mechanical work. Provide products with the proper or correct power characteristics, fuel-burning characteristics and similar adaptations for this project. Coordinate the selections from among options (if any) for compatibility of products.
- C. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.
- D. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- E. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- F. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.10 PERFORMANCE REQUIREMENTS

- A. Examine all Mechanical, Electrical, Architectural, Site and Structural Drawings, and available soil reports. Visit site and become acquainted with all conditions which may affect execution of work.

- B. Provide all work in accordance with State and Local Codes, Regulations and/or Ordinances, and meet approval of authorities having jurisdiction. Provide only new material and as specified.
- C. Furnish to the Owner, with a copy to the Owner a Certificate of Final Approval from governing authority prior to Owner's final acceptance, where applicable.
- D. General Outline: The facilities and systems of the mechanical work include all Division 22 Sections.
- E. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- F. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.11 PERMITS AND FEES

- A. Unless specifically described differently in another front-end specification section, all permits and fees of every nature required in connection with this work shall be obtained and paid for by contractor, including installation fees and similar charges.
- B. Laws and regulations which bear upon or affect the various branches of this work shall be complied with.
- C. All work which laws require to be inspected shall be submitted to the proper public officials for inspections and certificates of final approval must be furnished to the Owner before final acceptance will be given by the Engineer.

1.12 RECORD DRAWINGS

- A. Provide and maintain on the work site 1 complete set of Record Drawings for the Division 22 work. Carefully record on this set of drawings all work including fixtures, equipment, piping, fittings, components, etc which is installed differently from that indicated on the Drawings; locate dimensionally from fixed points all buried piping including depths relative to finish floor or finish grade elevations as applicable. The depth shall also be indicated for all plugged wyes, tees and capped lines. Mark all changes of location of piping, fixtures and equipment in accordance with Division 1 Sections.
- B. All existing lines discovered shall be indicated on these Drawings and located dimensionally from fixed points along with depths, if buried.
- C. The Record Drawings shall be continuously kept up-to-date and shall be available for inspection anytime during normal working hours.

- D. At completion of the work, provide a neat and legible reproducible set of the Record Drawings, which shall be individually signed and dated by the Contractor and Project Supervisor as to their accuracy.
- E. Such drawings shall be submitted to for acceptance and approval to the Owner before a final certificate of acceptance will be issued.

PART 2 - PRODUCTS

2.1 DIELECTRIC FITTINGS

- A. Dielectric fittings shall be provided where two materials of different types of metal connect or come in contact with each other.

2.2 MERCURY FREE DEVICES

- A. Do not provide any devices containing mercury, unless there is not a mercury free device on the market, which will perform the same function.

2.3 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Coordinate subparagraph and list below with Part 2 "Manufacturers" Article. Retain "Available" for nonproprietary and delete for semiproprietary specifications.
- C. Manufacturers:
 - 1. Hilti, Inc.
 - 2. B-Line Systems, Inc.; a division of Cooper Industries.
 - 3. ITW Ramset/Red Head.
 - 4. Masterset Fastening Systems, Inc.
 - 5. MKT Fastening, LLC.
 - 6. Powers Fasteners.
 - 7. Empire Fastening, LLC

2.4 FLOWABLE FILL - CONTROLLED LOW STRENGTH MATERIAL

- A. Description

1. A Controlled-Low-Strength-Material (CLSM) is a material that has a specified compressive strength of 1200 pounds per square inch (PSI) or less at 28 days. This material is not concrete and is in a flowable state at the time of placement.

B. Materials

1. A CLSM mixture consists of water, Portland Cement, Type "F" fly ash and fine aggregate.
2. If fly ash is not used, CLSM may be produced using high dosages of an air entraining admixture to help flowability and lower strength for removability.
3. Non-standard materials may be used with the approval of the Engineer.
4. Cement shall be Type I or II Portland Cement conforming to ASTM C-150 and Type "F" fly ash.
5. Water used in mixing or curing shall be as clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product as possible. Water will be tested in accordance with the requirements to AASHTO T 26. Water known to be of potable quality may be used without testing.
6. Fine aggregates conforming to ASTM C 33 shall be used in CLSM.

C. Mix Design

1. The proportion of materials used in CLSM shall be as follows:

a. Material	Quantity
b. Cement	50-100 pounds (lbs) per cubic yard (cy)
c. Type "F", Fly Ash	250-300 lbs/cy
d. Sand	2700-2800 lbs/cy
e. Water	400-500 lbs/cy
2. Other proportions may be used upon approval of the Engineer.
3. The mixture used shall conform to the following flowability test:
 - a. A 3-inch diameter by 6-inch long open ended cylinder will be filled with the mixture, then struck off to level. The cylinder will be removed by pulling straight up and the diameter of the CLSM, after spreading, must be a minimum of 8-inches.

D. Mixing and Transportation

1. CLSM must be transported by mixer truck. Agitation is required at all times from mixing to placement.

E. Placement

1. CLSM shall be placed directly from the truck chute or it may be pumped. No additional compaction is required.

PART 3 - EXECUTION

3.1 MANUFACTURERS

- A. Provide products from manufacturers regularly engaged in the manufacture of products of quality, types and sizes required; and which have been in satisfactory use of not less than four (4) years in similar service, except as otherwise noted in specific sections of this division.

3.2 COORDINATION OF PLUMBING WORK

- A. Refer to Division 1 Sections for general coordination requirements applicable to entire work. The contract documents are diagrammatic in showing certain physical relationships which must be established within mechanical work, and in its interface with other work, including utilities, control and electrical work.
- B. Arrange plumbing work in a neat, well organized manner, with piping and similar services running parallel with primary lines of the building.
- C. Give right-of-way to piping which may slope for drainage.
- D. Locate operating and control equipment properly to provide easy access, and arrange entire plumbing work with adequate access for operation and maintenance.
- E. Advise other trades of openings required in their work for the subsequent move-in of large units of plumbing work (equipment).
- F. Strictly adhere to invert elevations for all underground piping. Pitch piping evenly between pipe junctions and where indicated on the drawings. Piping, not installed at invert elevations indicated on the drawings, shall be removed and re-laid.

3.3 INTERRUPTION OF UTILITIES

- A. This project includes elements of work that will require disconnection and modification of existing systems, with resultant outages. These episodes must be strictly limited and controlled. No outage affecting any portion of the existing facilities will be allowed without specific written authorization by the Owner.
- B. The Contractor shall schedule and coordinate all interruptions of utilities with the applicable utility provider and the Owner within 20 working days after award of contract. At least 3 working days prior to the interruption, the Contractor shall submit to the Owner a schedule request indicating the proposed date, time and duration of interruption, the work to be accomplished, the area(s) that will be affected and a proposed contingency plan to be followed in the event that normal services or facilities cannot be restored on schedule. Do not commence with the work until the Owner has approved the time, date and contingency in writing.

- C. Provide all labor, materials, equipment and personnel necessary to restore services on a contingency basis should normal service of facilities not be restored on schedule.

3.4 DAMAGE BY LEAKAGE

- A. The Contractor shall be responsible for damage to the grounds, walks, roads, buildings (including walls, floors and ceilings), piping systems, mechanical and electrical systems (and their related equipment and contents) caused by leakage in the piping systems being installed or having been installed herein. The Contractor shall repair all damage caused at no additional cost to the Owner. All repair work shall be performed as directed by the Owner.

3.5 EMERGENCY REPAIRS

- A. The Owner reserves the right to make emergency repairs as may be required to keep equipment in operation without voiding the Contractor's guarantee bond or relieving the Contractor of his responsibilities.

3.6 PHASING

- A. General: Where the scope of work dictates that the project shall be constructed in phases, all costs shall be included for any temporary work required so that previous phases can be operational while construction is being done to adjacent spaces.

3.7 SUPERVISION AND WORKMANSHIP

- A. Workmanship throughout shall conform to the standards of best practice and all labor employed must be competent to do all the work required.
- B. Furnish the services of an experienced superintendent to be in constant charge of the work at all times.
- C. Quality Assurances: If requested, provide documentation that confirms the ability to perform all work to be included under the contract. Assurance if requested, shall be in the form of a list of past projects of similar size and complexity and a list of six (6) references pertaining to those projects. Failure to demonstrate these quality assurances shall be taken as a statement of inability to perform.
- D. A minimum of five (5) years experience in the installation of plumbing systems similar to the systems specified is required.
- E. Core Drilling: Use core drills rather than percussion type equipment for making holes in concrete. All percussion type drilling including hammer drills must be scheduled through owner's representative.

- F. Inspection: Provisions shall be made for owner's representative to make rough-in and open ceiling inspections prior to covering up work.

3.8 LOCATIONS AND INSPECTION OF SITE

- A. The Contractor shall fully familiarize himself regarding any and all peculiarities and limitations of the spaces available for the installation of all work and materials furnished and installed under this Contract. Coordinate with all other trades in advance of the work, requirements for openings, recesses and chases in the walls, partitions, equipment housekeeping pads, framing or openings, requirements for servicing equipment and routing of piping relative to each trade to alleviate conflicts. Should furnishing this information be neglected, delayed or incorrect and additional cutting is required, the cost of it shall be borne by the Contractor. Nothing in this paragraph shall be construed to relieve the Contractor of the responsibility for providing and paying for the required core drillings and openings in existing work.
- B. Diagrammatic indications on the Drawings are:
 - 1. Approximate only.
 - 2. Shown distorted at various locations.
 - 3. Possibly moved for visual clarity.
- C. Exact locations shall:
 - 1. Be required for proper installation in available space.
 - 2. Be as required to preserve the required space for the servicing of equipment and components.
 - 3. Avoid interference with Architectural and Structural features and the work of all other trades.
 - 4. Be coordinated with the work of all other trades toward the general purpose of having the work progress rapidly and smoothly with a minimum interference between one trade and another.
 - 5. Preserve headroom and keep openings and passageways clear.
 - 6. Conceal all piping above ceilings, in walls, pipe shafts, pipe spaces and furring whenever possible.
- D. Include a neat, orderly arrangement of piping symmetrical to building lines, light and tile patterns and other building elements. Any deviations not shown on the Drawings shall be requested in writing prior to implementation.

3.9 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Protect products against dirt, water, chemical and mechanical damage. Do not install damaged products.

- B. Deliver products to site in factory fabricated containers, with the manufacturer's label clearly visible. Handle carefully to avoid damage to components, enclosure and finish, and in strict accordance with manufacturer's instructions.
- C. Store products in clean dry place in original containers, protected from weather and construction traffic.

3.10 SUBSTITUTIONS

- A. A substitution is the use of any product other than that identified as the "Basis of Design," the "Standard of Quality," or an "Additional Approved Product."
- B. Substitutions require pre-bid approval. Only substitutions authorized via addendum shall be considered.
- C. Substitutions are considered on a product-by-product and model specific basis.
- D. Substitution Submittal Requirements:
 - 1. Substitution requests must be received by the Designer sufficiently in advance of the scheduled bid date to allow time for review and issuance of an Addendum. If the timing of the request does not permit an Addendum, substitution shall not be considered or acceptable.
 - 2. Substitution requests shall consist of the following for each proposed substitution:
 - a. Substitution Request Letter:
 - 1) On company letterhead, for each specific product substitution request. The letter shall include the following:
 - a) The specification section and paragraph number and drawing number where the product requirement is identified.
 - b) The specific system in which the product is to be used.
 - c) The reason the Contractor is requesting the substitution.
 - d) Statement of impact on the system(s) in which the product is used.
 - e) An enumeration declaring each difference between the Basis of Design product and the proposed substitute, including performance differences, technical specifications difference, feature differences, method of operation differences, warranty differences, dimensional differences, method and means of control differences, compliance differences. Failure to disclose 100-percent of the differences in this manner may be grounds for a post-bid and/or post-installation rejection of Contractor proposed substitute product.
 - 2) A separate letter shall be furnished for each product substitution request.
 - b. Product Datasheets/Brochures:
 - 1) Complete system brochure(s) and/or individual product data sheet(s), as applicable and appropriate for the Basis of Design product(s) the requested substitute is intended to replace.
 - 2) Complete system brochure(s) and/or individual product data sheet(s), as applicable, for the proposed substitute product(s).

3. Failure to furnish the required information is sufficient grounds for rejection of the request for substitution.
 4. A demonstration of the proposed substitute equipment and/or system(s) may be required by the Designer prior to consideration of substitute products or system(s). Costs associated with these demonstrations are the responsibility of the entity submitting the request.
 5. Substitution Pre-Bid Submittal Exceptions:
 - a. Additional Approved Manufacturer(s):
 - 1) These specifications may use phrases such as “or equal by,” or “Additional Approved Manufacture(s)” for products. When a product category uses these designations, it is an indication that a product model from one of the listed manufacturer(s) may be provided without the requirement to obtain pre-bid approval for the model selected, provided that the Contractor has adequately researched and has become familiar with the Basis of Design product and intends to supply a model that is equal to or superior than the Basis of Design product.
 - 2) Since it is impractical to enumerate every characteristic of modern electronic products, it is incumbent upon the Contractor to research manufacturer’s publications to obtain the fullest possible understanding of Basis of Design / Standard of Quality products the Contractor proposes to substitute with a product from any Additional Approved Manufacturer considered.
 - 3) Although not mandatory, for the Contractor’s own protection, model specific pre-bid approval is strongly encouraged.
 - 4) The decision as to whether a Contractor selected model from a list of Approved Additional Manufacturer(s) is acceptable remains solely with the Designer, and the Designer’s decision is final.
- E. Costs that result from the use of substitute products and/or Additional Approved Manufacturer(s), including costs for additional equipment, coordination, accessories, modules, interface products, cables, software, and programming, as well as costs for any additional labor, materials, and products incurred by other trades or members of the project Design Team or Owner, are the sole responsibility of the Contractor making the substitution. This includes costs that may not be incurred or known until after Contract award or Work execution. Such costs shall be deducted from final sum payable to the Contractor.
- F. Post Contract award substitutions may be considered, but only if the proposed substitution includes substantial additional benefit to the Owner. Post award substitutions are considered solely at the discretion and convenience of the Designer. For a post Contract award substitution to be considered, one or more of the following shall apply:
1. The Designer initiates the request for substitution.
 2. A basis of design product has become discontinued and is no longer available, and as a result, the use of a substitute product has become a necessity to meet the Owner’s objectives for the Project. See “Discontinued Products.”
 3. The request for substitution is accompanied by a proposal that identifies the benefits to the Owner, including a fair-market Contract price reduction.

3.11 EXPLANATION AND PRECEDENCE OF DRAWINGS AND SPECIFICATIONS

- A. Prior to submitting his bid, the Contractor shall review all Drawings and Specifications to determine any conflict with all applicable local codes, rules or regulations. The Contractor shall obtain clarification of such during bidding.
- B. When the work as indicated on the Drawings and/or Specifications exceeds the minimum required by any code, standard, rule or regulation, the Drawings and/or Specifications shall govern the design and installation of the work.
- C. For purposes of clarity and legibility, the Drawings are essentially diagrammatic although size and location of equipment are drawn to scale wherever possible. The Contractor shall make use of and verify all information on the Drawings and Specifications.
- D. The Contractor shall fully inform himself regarding any and all peculiarities and limitations of the spaces available for the installation of all work and materials furnish and installed under this Contract. He shall exercise due and particular caution to determine that all parts of his work are made readily accessible.
- E. The Drawings indicate required sizes and points of termination of piping and suggests proper routes to conform to structure, avoid obstructions and preserve clearances. However, it is not intended that the Drawings indicate all necessary offsets, and it shall be the work of the Contractor to make the installation in such a manner as to conform to the structure, avoid obstructions, preserve headroom, keep openings and passageways clear and maintain required service clearances without additional cost to the Owner.
- F. Significant changes by the Contractor in design, sizing and/or location of system piping, fixtures and/or equipment as shown on the Drawings are prohibited without prior written approval by the Owner. Should the Contractor fail to obtain the Owner's written approval and proceed to make these unauthorized changes, he does so at the risk of accepting total responsibility and related costs therein for the design elements he may alter.
- G. It is intended that all plumbing devices, piping, etc. be located symmetrically with all Architectural elements. Refer to the Drawings and Specifications of all disciplines in completing the required coordination.
- H. Where the Drawings and/or Specifications are in conflict, obtain clarification of such during bidding. Official clarification will only be given in written form. Any clarification issued by other than written form will not be considered official and shall be non-binding for work under this Contract. Where clarification cannot be delivered in a timely manner, the Contractor shall base his bid on the greater quantities, higher standards or more restrictive requirements. In the event of discrepancies in the Drawings and/or Specifications after the bid period, the Contractor shall advise the Architect and Engineer of such prior to proceeding with the work in question in order that correct progress of the work may be insured.

- I. Prior to submitting his bid, the Contractor shall review all Drawings and Specifications to determine any conflict with all applicable local codes, rules or regulations. The Contractor shall obtain clarification of such during bidding as outlined above.
- J. The submittal of his bid shall indicate the Contractor has examined the site; all applicable local codes, rules and regulations; the Drawings and Specifications and has included all required allowances in his bid. No allowance shall be made for any error or omission resulting from the Contractor's failure to visit the job site and/or review the Drawings and Specifications. The Contractor's bid shall include costs for all required drawings and changes as outlined above at no additional cost to the Owner.

3.12 CUTTING, PATCHING, AND DEMOLITION

- A. Refer to Division 1 Sections "Cutting and Patching" and "Selective Demolition" for general demolition requirements and procedures.
- B. Contractor shall include all necessary cutting and patching required to perform their work. For interior work, cut and patch all walls, ceilings, and floors as applicable. For exterior work, provide saw-cutting, replacement of concrete, paving, re-seeding/straw for grassy areas, and replacement of landscaping areas where applicable.
- C. All cutting of concrete work by the Contractor shall be by core drilling or concrete saws with dust collection systems. No cutting or coring of structural members shall be done without first obtaining the permission of the Owner. All cuts by the Contractor shall be plumb, square and true.
- D. Core Drilling: Use core drills rather than percussion type equipment for making holes in concrete. All percussion type drilling including hammer drills must be scheduled through the Owner.
- E. All patching of existing, adjacent surfaces shall match existing material and finish in a manner satisfactory to the Architect.
- F. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed and as necessary to perform the described scope of work.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

- G. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
- H. No means of demolition shall be used that would result in damage to structures, materials, equipment or components indicated to remain or endanger the health, safety and welfare of the general public. The use of explosives is strictly prohibited. Where piping, insulation, fixtures, equipment or components to remain are damaged or disturbed, remove damaged portions and install new products of equal capacity and quality, subject to the approval of and at no additional cost to the Owner.
- I. Demolition Scope of Work:
 - 1. Before beginning demolition, make all arrangements required to turn off and disconnect utilities and other such facilities involved.
 - 2. The Owner has the right of first refusal of all removed materials as indicated on the Drawings. All items designated to remain as the Owner's property shall be removed, cleaned and presented to him as he may direct.
 - 3. All items to be removed and relocated shall be removed and responsibly stored, cleaned, repaired (as required and to satisfactory working order), reinstalled (complete with new fittings, trim, etc), reconnected and made operational by the Contractor.
 - 4. All other demolished items shall become property of the Contractor and shall be responsibly disposed of in accordance with applicable codes and regulations or salvaged. All costs associated with disposal or salvaging are the Contractor's responsibility.

3.13 SYSTEM TESTS

- A. Perform all system tests in the presence of an authorized representative of the Owner and local authority having jurisdiction as applicable. Notify the Owner of all system's tests at least 48 hours in advance.

3.14 EXCAVATING AND BACKFILLING

- A. Refer to the site utility specifications for additional requirements for exterior piping excavation and backfilling.
- B. Comply with all codes in jurisdiction. Provide slope sides, shore and brace as required for stability.
- C. Perform all excavation and backfilling required for his work and shall consult with utilities prior to beginning excavation.
- D. Remove materials of every nature and description encountered in obtaining indicated lines and grades as shown on drawings. No extras will be allowed due to variations of proportion and the variation of materials.

- E. At a minimum, all piping shall be laid on a bed of sand, 6" deep, well tamped into place and properly graded to permit the pipe to have an even bearing throughout its entire length. Sand shall be installed around the piping and to a point 6" above the piping.
- F. Excess excavated earth materials shall be removed from the site.
- G. All backfilling above piping shall be flowable fill or bankrun gravel with clay compaction above to the subbase.
- H. All backfilling under pavement and sidewalks shall be flowable fill up to paving base/subbase material(s). All excavations shall be compacted to prevent settling.
 - 1. Roadways, walks and slabs 100%
 - 2. Yard areas 95%
- I. Compaction shall be performed in 12" lifts and spread evenly.
- J. Pay for all expenses for the proper restoration of all streets, sidewalks, concrete and blacktop surfaces broken for installing piping.

3.15 CLEANING PREMISES

- A. During the progress of the work, clean up and leave the premises and all portions of the building in which work was performed in a clean and safe condition. Refer to Division 1.
- B. Dispose of construction waste in accordance with Division 01 section "Construction Waste Management and Disposal".

3.16 MAINTENANCE, OPERATION INSTRUCTIONS, ETC.

- A. General: Before final acceptance of the project by the Owner, the Contractor shall schedule with the Owner's maintenance personnel, at a time mutually convenient, a training session. At this time, he will thoroughly familiarize the Owner's maintenance personnel with all operating and service procedures (routine and emergency) associated with the building systems and equipment. Provide the Owner with a list of all equipment including the following information:
 - 1. Manufacturer's name.
 - 2. Equipment model number
 - 3. Equipment serial number.
 - 4. Local sales representative (including postal & email addresses and telephone & fax numbers).
 - 5. Parts list, complete with source(s) of supply.
 - 6. Complete internal wiring diagrams.
 - 7. Warranties.

- B. All directions for operation furnished by the manufacturer shall be carefully saved and turned over to the Owner, together with written sequence of operation, operating and maintenance schedules & instructions (routine and emergency) for each system and its equipment. All verbiage and units of measure shall be in English.

3.17 PROJECT SITE SAFETY

- A. The Engineer claims no expertise in and assumes no responsibility for any and all safety procedures and protocols associated with the Contractor's work. The Contractor shall exercise due diligence and comply with all established safety standards and regulations as listed by OSHA and any equipment manufacturers' requirements as they may relate to personal safety. The Contractor shall insure that all of his subcontractor(s) and/or tradesmen are apprised of all safety-related standards and procedures as they may relate to their work and immediately correct any violation of OSHA standards and regulations or equipment manufacturers' safety recommendations.

3.18 WORK IN EXISTING SPACES

- A. General: Care shall be taken when working in existing spaces so as not to damage existing walls and ceilings where work is being performed.
- B. Existing Ceilings: Where work is being performed above ceilings, and the architectural drawings do not indicate ceiling modifications are the responsibility of others, remove and replace existing ceilings where work is being performed. In those instances, costs for all repair and installation of new grid, ceiling panels, etc shall be included. Match existing finishes.
- C. New Ceilings: Where existing sprinklers are to remain, and the architectural drawings indicate replacement of the ceilings, temporarily remove and reinstall sprinkler escutcheons, etc. as required to accommodate the ceiling removal.
- D. Walls & Floors: Patch existing walls and floors and match existing finishes where work is being removed or installed and patching is being performed, unless noted otherwise on the architectural drawings.

3.19 ARCHITECTURAL COORDINATION ITEMS

- A. Cut and drill all openings in walls and floors required for the installation. Secure approval of Engineer before cutting and drilling. Neatly patch all openings cut.
- B. Cutting and patching to be held to a minimum. Coordinate locations of sleeves and openings before construction is started.
- C. Patching through fire rated walls and enclosures shall not diminish the rating of that wall or enclosure. Patch shall be equal to rockwool, firestop, caulk or approved "rated" patch.

- D. Caulk or fire safe between sleeves and pipes, see Division 7 for caulking and fire-safing requirements and the floor plan and partition schedule for partition ratings.
- E. Furnish all access panels required for proper servicing of equipment. Provide access panels for all concealed valves, controls, and sprinkler devices required by NFPA. Provide frame as required for finish. Exact locations to be approved by the Architect. Minimum size to be 12" x 12", units to be 16 gauge steel, locking device shall be screwdriver cam locks. Refer to Division 9 for access panel manufacturers and material requirements. Provide phenolic plate with ID of item behind access panel on the face of the door.
- F. Install steel pipe sleeves two sizes larger than pipes passing through floors, walls or masonry construction.
- G. Sleeves through walls to be cut flush with both faces.
- H. Sleeves through floor to extend one inch above floor top elevation.
- I. Caulk or fire safe between sleeves and pipes, see Division 7 for caulking and fire-safing requirements and the floor plan partition schedule for partition ratings.
- J. Install manufactured chromium plated escutcheon plates wherever uninsulated exposed pipes pass through walls, floors, or ceilings. Escutcheon inside diameter to closely fit around pipe and outside diameter to completely cover opening.
- K. Furnish and set all forms required in masonry walls or foundation to accommodate pipes.
- L. Provide flexible connectors where all pipes cross building expansion joints. Coordinate exact quantity & location with Architectural plans prior to installation of piping.

END OF SECTION 220500

SECTION 220503 - SUBMITTALS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections and Division 22 General Requirements Section apply to this Section.

1.2 SUMMARY

- A. Section Includes: Administrative, content and format requirements for preparation and submission of submittals.
- B. Work of this Section is supplemental and additive to the requirements of Section 013300 where included in the Project Manual.

1.3 PRICE AND PAYMENT PROCEDURES

- A. Payment in full or in part may be withheld from the Contractor for failure to comply with submittal requirements articulated in the Contract Documents.

1.4 SUBMITTALS

- A. Submittals shall be furnished for each Section that includes one or more of the following elements of work:
 - 1. Supply of one or more products.
 - 2. Installation of one or more products.
 - 3. Integration of one or more products.
 - 4. Creation of one or more deliverable products.
 - 5. Labeling of one or more products.
 - 6. Contractor-based design or engineering of one or more products or systems.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Submittals shall be routed through established Project channels as identified by the Owner's representative.

- B. Coordinate, assemble, title, transmit and track Project submittals.
- C. Label each submittal of each type similarly for consistency and so they appear as if prepared by the same entity. Like-type submittals (e.g., Product Data) from different Sections shall feature the same appearance and organization as those of other Sections.
- D. Submittals prepared by subcontractors or vendors shall not be accepted unless prepared in compliance with the Contract Documents.
- E. Submittal items listed in this Section represent the common items required to be supplied for the various specification Sections throughout the duration of the Project. Individual Sections will vary and may include additional or lesser requirements.
- F. Designer reserves the right to require additional submittals or to waive select submittal requirements on a Section-by-Section basis. Additional submittals shall be provided at the Contractor's expense.
- G. The cost for preparation and transportation of submittals is Work of the Contract.
- H. Bind physical/hardcopy submittals together. Do not submit loose or paper clipped documents.
- I. Supply separate submittals for each Section. Do not combine multiple Sections together into a single submittal, except where expressly directed within the Contract Documents.
- J. Where electronic submittals are required or permitted, comply with the requirements for electronic submittals as identified in the Contract Documents.
- K. Organize submittals as identified in the Contract Documents.
- L. Furnish submittals for different Sections each with its own transmittal form. A single transmittal shall not be used to identify submittals for more than one (1) Section at a time. This allows for tracking and processing efficiency, so that:
 - 1. Each Section may be reviewed simultaneously by different individuals, as appropriate.
 - 2. Individual Sections may be processed and returned more quickly than others when some Sections require longer review times.
 - 3. Submittals that are returned and marked as "Revise and Resubmit" do not cause submittals for other Sections to be also be resubmitted due to the fact that they were bound together as a single unit.
- M. Use of Electronic Drawings from the Owner's Design Team:
 - 1. Plan drawings for the Project were created with AutoCAD .

2. If expressly permitted by the Owner and the terms of the Contract, editable electronic versions of standard-scale, AutoCAD-based plan drawings may be made available for the creation of shop and as-built drawings.
3. Due to the proprietary nature of internal design systems, editable native-software versions of some drawings, including but not limited to system diagrams and details will not be made available in an editable form. In these cases, electronic versions of the drawings may be made available only in PDF, JPG or similar non-editable electronic form, at the sole discretion of the Designer.

3.2 SUBMITTAL TYPES

A. The following are the common submittal types referenced in this Section:

1. Quality Assurance (QA).
2. Quality Control (QC).
3. Product Data (PD).
4. Shop Drawing (SD).
5. Training (TG).
6. Field Observation Response (FO).
7. Closeout Submittal (CO).

3.3 SUBMITTAL SEQUENCE

A. Quality Assurance Submittal:

1. When not expressly requested to be supplied with bid, the Quality Assurance submittal(s) shall be supplied upon request. When requested the submittal shall be delivered to the Designer within 16 business hours.

B. Product Data Submittal:

1. Submit following contract award or notice of intent to award a contract. Product data shall be submitted and reviewed prior to procurement of materials.

C. Shop Drawing Submittal:

1. Submit for review prior to commencement of fabrication and installation.
2. Submit concurrently with Section-specific Product Data submittals.

D. Samples Submittal:

1. Submit concurrent with, or soon after, product data and shop drawings and prior to installation of Work.

E. Training Submittal:

1. Submit thirty (30) days prior to the first training session.

F. Field Observation Report Submittal:

1. Submit five (5) business days prior to punch list walkthrough.

G. Closeout Submittal:

1. Submit following completion of onsite work but not more than ten (10) business days following successful Acceptance Testing.

3.4 SUBMITTAL IDENTIFICATION

A. Identify each submittal uniquely.

B. Identify each submittal by specification Section number, submittal type, and submittal iteration.

C. The format for labeling the submittals shall be as follows:

1. Section Number–Submittal Type Abbreviation–Submittal Iteration.
2. Examples:
 - a. First Product Data Submittal for section 224000: “224000-PD-00.”
 - b. Revised Product Data Submittal for section 224000: “224000-PD-01.”
 - c. Second Revised Product Data Submittal for 224000: “224000-PD-02.”

3.5 SUBMITTAL CONTENTS

A. All Submittals:

1. Transmittal:
 - a. Supply a dedicated transmittal for submittals for each individual Section.
 - b. Itemize the specific submittals included by Section, submittal type, and iteration.
2. Title Sheet:
 - a. Include a separate title sheet with each submittal, of each type.
 - b. Title sheets for each Section, for each submittal type, shall have the same appearance.
 - c. Title sheets for product data submittals shall be 8-1/2 inches x 11 inches.
 - d. Title sheets for drawings shall be the same size as the associated drawings.
 - e. Create title sheets to have the appearance and information identified on the sample title sheet published at the end of this Section.
3. Index:
 - a. Include an index outlining and identifying the contents of the submittal.
 - b. The index for drawing submittals shall be incorporated onto the title sheet of the corresponding drawing set.

4. Checklists:
 - a. Include the checklist(s) published in the Contract Documents corresponding to the type of submittal being supplied. Applicable checklists are found at the end of this Section and may also be found within individual Sections.
 5. Title Blocks:
 - a. Drawing submittals shall be created on the Contractor's, manufacturer's, or vendor's own title block. The title blocks of the Owner, Architect, Engineer, Designer or their Consultants shall not be reproduced on any document (electronic or hardcopy) that is prepared or altered by the Contractor.
 6. Legend:
 - a. Drawing submittals shall include a legend of symbology.
 7. Resubmittals:
 - a. Resubmittals shall include a replica of the reviewer's comments that necessitated the resubmittal, along with an accompanying item-by-item explanation of the actions taken and changes that will be found within the resubmittal.
- B. Quality Assurance Submittals:
1. List of Subcontractors to be used on the Project along with a description of the role each will play on the Project.
 2. The last six (6) projects that the Contractor (and each proposed Subcontractor) has completed that are of similar scope, size and contract value. References shall include:
 - a. Owner's name and current contact information.
 - b. Project address.
 - c. Description of the system(s) and scope of actual work performed.
 - d. Monetary contract value of the Work performed.
 3. Financial Disclosure of the Contractor: Prior to contract award, upon request.
- C. Product Data Submittals:
1. Bill of Materials (BOM):
 - a. Separate list for each system:
 - 1) When a Section covers products for use in multiple systems, supply separate BOM for each unique system covered by the Section. Label each with the system name, space/room name, and room number.
 - b. Include the following:
 - 1) Make, model, and description of each product.
 - 2) Quantity estimates for each product.
 - 3) Section paragraph number from which the product requirement is derived. Use drawing and detail references when the requirement is derived from the Drawings.
 - c. Organize the BOM to follow the order in which products appear within the Section. Products shown on the Drawings but not enumerated within the Specifications shall be placed at the end of the list and include a reference to the Drawing from which the product requirement was derived.

2. Product Datasheets Submittals:
 - a. Separate manufacturer datasheets for each product.
 - b. Datasheets shall be manufacturer originals or first generation printed versions (i.e., from PDF) of the manufacturer's official electronic datasheet:
 - 1) Distributor modified, distributor branded, and/or html based "web" datasheets are not acceptable.
 - 2) Datasheets shall include size and technical support data.
 - c. Where manufacturer's datasheets depict multiple products, versions and options, indicate via highlighting, underlining, or with bold visible arrows the model(s), version(s) and option(s) being supplied. Exact catalog number(s) shall be indicated.
 - d. Each datasheet shall be labeled with the Section paragraph reference number. Datasheets shall include the Drawing reference when no specific paragraph reference exists within the Section.

D. Shop Drawing Submittals:

1. General:
 - a. Drawing descriptions identify the required contents of common drawings required under the Contract.
 - b. Drawings identified within individual Sections, along with any additional drawings deemed necessary by the Designer, are required.
 - c. Drawing Scales:
 - 1) Floor plans shall be drawn to scale.
 - 2) Section drawings shall be drawn to scale.
 - 3) Elevation drawings shall be drawn to scale.
 - 4) Details of physical items shall be drawn to scale.
 - d. Sizes:
 - 1) Sheet sizes shall match the size of the Contract Drawings sheets, except where otherwise expressly requested or approved in advance by the Designer.

E. Training Submittals:

1. Proposed schedule.
2. Training agendas for each session.
3. Identification of personnel that will conduct training.
4. Handouts proposed for distribution during training.

F. Field Observation Report Submittals:

1. Written responses to Field Observation Reports supplied to the Contractor during the course of the Project:
 - a. The response shall include a copy of the original Field Observation Report.
 - b. The response shall include detail of the corrective action taken, the date the action was taken and the identity of the individual who took the action.

G. Closeout Submittals:

1. As-Built Drawings:
 - a. General:
 - 1) Requirements for Shop Drawings apply to “As-Built” drawings.
 - b. Required Drawings:
 - 1) Title Sheet.
 - 2) Floor Plans.
 - 3) As-built version of each Project shop drawing.
 - c. Drawing Formats:
 - 1) Electronic Editable: Editable version using the native application used to create the file (e.g., Revit, AutoCAD).
 - 2) Non-Editable: PDF file format.
 - 3) Printed Hardcopy.
 - 4) Sheets shall be the same size and feature consistent title block information in the lower-right corner.
 - d. Drawing Organization:
 - 1) Hardcopy drawings shall be bound together into logical sets, bound along the left edge of the sheets.
 - 2) The first page of the set shall include a detailed index and sheet-by-sheet description of each drawing sheet.
2. Operation and Maintenance Manuals:
 - a. Manual Format:
 - 1) Hard-cover 3-ring type binder.
 - 2) Front clear plastic cover pocket complete with Project and system Information insert.
 - 3) Clear plastic spine pocket with Project and system Information insert.
 - 4) Binder sized to suit the contents only, neither oversized nor undersized.
 - 5) Maximum binder thickness: 3 inches.
 - b. Manual Contents and Organization:
 - 1) General:
 - a) Separate binder (or binder set) for each system, labeled. Provide no more than one system per binder (or binder set).
 - b) Separate CD-ROM (or CD-ROM set) for each system, labeled. Provide no more than one system per CD-ROM (or CD-ROM set).
 - c) Do not overfill. Binders shall not be filled beyond an easily usable capacity.
 - d) Insert labeled tabs within binder to identify separate contents of the manual.
 - e) Labeled sub-directories shall be created on the CD-ROM to label and separate contents for the manual.
 - 2) Project Information Cover:
 - a) Title of Project.
 - b) Name and address of Owner, Designer, Architect, Contractor of Record and Subcontractor.
 - c) System name and specification references.
 - 3) Index:
 - a) Contents of the manual.
 - 4) Warranty Statement:
 - a) A warranty statement shall be included for each system. The warranty statement shall reiterate the terms of warranty identified

- within the Contract Documents, as well as identify how the Owner is to obtain warranty service.
- b) The warranty statement shall clearly identify which products are covered by Manufacturer warranties beyond the Contractor required minimum warranty period. The term of manufacturer warranty shall also be identified (e.g., 2 year parts and labor).
 - c) A separate warranty statement shall be supplied for each system.
 - d) Identify the date that the warranty for the system starts. This date shall be the date listed on the Certificate of Substantial Completion (if one was issued to the contractor specifically for the system) or the date listed on the Notice of Final Completion.
 - e) Supply standard out-of-warranty service rates and service contact information.
- 5) Bill of Materials:
 - a) List of products supplied.
 - b) Serial numbers of each product.
 - 6) Product Datasheets (supply only in the electronic version of Operation and Maintenance Manual):
 - a) Manufacturer datasheets for each product supplied.
 - 7) Manufacturer Owner / User Manuals:
 - a) Manufacturer's Owner's or User's manual for each product.
 - b) Manufacturer's Installation instructions and other documentation supplied with the product.
 - 8) Test Reports and Checklists:
 - a) Test reports, checklists, and other forms generated and completed during the course of the Project.
 - 9) Training Information:
 - a) Photocopy of training outlines / agendas.
 - b) Photocopy of training session handouts.
 - c) Photocopy of training sign-in sheets.
 - d) Photocopy of signed delivery receipt for each training session recording (applicable to those Sections/systems requiring recording).
 - 10) As-Built Drawings:
 - a) The hardcopy manual shall contain reduced scale printed version (11x17) of system-specific drawings.
 - b) The electronic manual shall contain electronic PDF version of the as-built drawings.

3.6 SUBMITTAL QUANTITY

A. General:

- 1. The quantity of submittals required shall be the greater of the following:
 - a. Quantity identified within Division 01.
 - b. Quantity identified within the individual Section.
 - c. Quantity identified herein.

2. In addition to the Contract required quantity, the Contractor shall also submit any additional quantities required for its own use and records, and for distribution to other trades.
3. The Designer shall retain a copy of each submittal received. Others in the submittal communication chain may also retain copies.

B. Product Data Submittals:

1. Two (2) Hardcopies.
2. One (1) Electronic.

C. Shop Drawings Submittals:

1. Two (2) Hardcopies.
2. One (1) Electronic.

D. Training Submittals:

1. Two (2) Hardcopies.
2. One (1) Electronic.

E. Field Observation Report Submittals:

1. Two (2) Hardcopies.
2. One (1) Electronic.

F. Samples Submittals:

1. Two (2) Hardcopies.
2. One (1) Electronic.

G. Closeout Submittals:

1. Two (2) Hardcopies.
2. One (2) Electronic.

3.7 SUBMITTAL REJECTION

A. The following items are representative reasons that submittals may need to be revised and resubmitted:

1. Binding submittals for multiple Sections together.
2. Failing to supply separate transmittal for submittals for each Section.
3. Failing to include a submittal title sheet.
4. Failing to use and accurately complete the published title sheet.
5. Failing to supply and accurately complete the submittal checklists.
6. Failing to supply product data and shop drawings at the same time.

7. Failing to include a detailed BOM with the product data.
8. Failing to supply product data sheets.
9. Failing to supply product data sheets with the correct product and required accessories enumerated.
10. Failing to supply shop drawings.
11. Failing to supply shop drawings with required information.
12. Failing to supply accurate information.
13. Failing to supply relevant information required by the Specifications.
14. Failing to supply products that are in compliance with the Specifications.
15. Failing to supply the required information in the required format.

3.8 RESUBMITTALS

A. Revise and Resubmit:

1. When a submittal is rejected and flagged as “Revise and Resubmit,” the entire submittal shall be reviewed, revised and resubmitted in totality.
2. Resubmittals shall be checked for compliance with the Contract Documents, inclusive of requirements for submittals. In addition, any comments and deficiencies identified by the reviewer shall be appropriately acted upon.

B. Exceptions Noted:

1. When a submittal is flagged as “Exceptions Noted,” the specific actions identified shall be taken.
2. If the reviewer’s comments include selective rejection of products, the resubmittal shall be limited to include those items commented upon.

C. Resubmittals shall:

1. Include a copy of the reviewer’s previous comments.
2. Include a written description of the action(s) taken.
3. Be labeled chronologically.
4. Be inclusive of all corrective action identified by the previous reviewer.

3.9 ELECTRONIC SUBMITTALS

A. Electronic submittals shall only be permissible where electronic submittals are expressly required and where express approval for such has been granted.

B. Electronic submittal files shall be compatible for opening and viewing with electronic PDF file readers that fully support and recognize the Adobe PDF Portable Document Format Standard, version 1.5.

C. Major text within the files shall be electronically searchable using the search-for-text features of current generation Adobe PDF reader software. Files shall be prepared in such manner that

reviewers will have the option to search for and find words and phrases that appear within the document, electronically. Documents featuring raster-based text and text that is otherwise not searchable shall not be acceptable. This precludes the use of documents that have been electronically scanned and then converted to or embedded within an electronic file.

D. The organization, contents, and labeling of information along with other requirements for submittals apply also to electronic versions of the submittals.

E. Single File Submission:

1. Option 1 – Single File, PDF Format:

- a. Single PDF file submittals shall be assembled from a series of individual files that are organized, indexed, bound together as one composite file that is bookmarked to aid the reviewer in navigating the content.
- b. The file shall feature a navigational tree of contents, organized by content groups (e.g., Title Page, Index, BOM, Datasheets, Shop Drawings). Content groups shall be organized in the same relative order identified within the Contract Documents.
- c. Within each content group shall be the supporting elements of the group (e.g., product datasheets under the Datasheets group). Each element of the content group shall appear separately as a subordinate element of the group (e.g., separate entry for each product datasheet, separate entry for each shop drawing), and viewable from the navigational contents tree.
- d. Under the Datasheets content group, individual product datasheet entries shall be identified by Make/Brand and Model. Entries shall be organized in a sorted manner, first by make, then by model.
- e. If the resulting size of the composite PDF file exceeds 10 Megabytes, supply the submittal using the Single Zip File method instead, as described in this Section.
- f. The file name used to label the submittal shall be the section number followed by the submittal instance number for that Section (e.g., 224000-PD-01.pdf).
 - 1) Where the Designer directs the supply of multiple zip files for a submittal, add additional text to the file name to identify that the file is part of a multi-file set of submittals, as per the following examples:
 - a) 224000-PD-01 (1 of 3).pdf
 - b) 224000-PD-01 (2 of 3).pdf
 - c) 224000-PD-01 (3 of 3).pdf

2. Option 2 – Single File, Zip Format:

- a. Single Zip File submittals shall be assembled from a series of individual PDF files and file directories that are contained with a single compressed WinZip compatible “.zip” file.
- b. The file shall contain separate top-level directories that are used to group related content (e.g., 00-Title Page, 01-Index, 02-BOM, 03-Datasheets, 04-Shop Drawings), with each directory appearing in the same relative order as that identified in the Contract Documents.
- c. Within each content group directory shall be separate PDF-compliant files featuring the information required (e.g., separate datasheet file for each product, separate file for each drawing, separate file for each BOM).

- d. Product datasheet files shall be named using a consistent naming convention that enables those files to appear sorted and grouped when the file is opened for navigation, viewing or extraction by the reviewer.
- e. Product datasheet files shall be consistently named with the make/brand of the product, followed by model number, followed by any additional information beneficial.
- f. Consult the Designer for supplement instructions should the WinZip file exceed 50 Megabytes in size.
- g. The file name used for the submittal shall be the Section number followed by the submittal instance number for that Section (e.g., 224000-PD-01.zip).
 - 1) Where the Designer directs the supply of multiple zip files for a submittal, add text to the file name that identifies the file is part of a multi-file set as per the following examples:
 - a) 224000-PD-01 (1 of 3).zip
 - b) 224000-PD-01 (2 of 3).zip
 - c) 224000-PD-01 (3 of 3).zip

END OF SECTION 220503

SUBMITTAL TITLE SHEET

EXAMPLE

(Form: Sub-1)

PROJECT TITLE:

Project Name Line 1

Project Name Line 2

Project Name Line 2

SUBMITTAL TYPE:

Product Data

SECTION SUBMITTAL NUMBER

224000-PD-00

SECTION TITLE:

Plumbing Fixtures

Date Prepared:

yyyy-mm-dd

CONTRACTOR OF RECORD:

Firm Name

Address 1

Address 2

City, State, Zip

Phone (000) 000-0000, Fax (000) 000-0000

Project Manager: Full Name

PM E-Mail: xxxxxxxx@xxxx.xxx

SECTION SUBCONTRACTOR(S):

<p>Firm Name Address 1 Address 2 City, State Zip Phone (000) 000-0000 Fax (000) 000-0000 PM Name: Full Name PM E-Mail: xxxxxxxx@xxxx.xx</p>	<p>Firm Name Address 1 Address 2 City, State Zip Phone (000) 000-0000 Fax (000) 000-0000 PM Name: Full Name PM E-Mail: xxxxxxxx@xxxx.xx</p>
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**PRODUCT DATA SUBMITTAL
CHECKLIST**

(Form: Sub-2)

Each line below featuring text shall be supplied with an answer.

	No	Yes
Transmittal		
Title Sheet		
Project Name		
Specification Section number		
Submittal iteration number <i>(0 for first iteration, 1 + for each subsequent iteration (e.g., 224000-0, 224000-1))</i>		
Contractor of Record identified		
Sub-contractor / vendor / supplier name identified		
Title Sheet appearance consistent with sample title sheet		
Bill of Materials		
Section paragraph and/or Drawing reference identified		
Make		
Model		
Product Description		
Separate lists included for each system		
Checklists included		
This checklist		
Checklists from Section being submitted (where applicable)		
Previous submittal review, with contractor actions and comments		
Product Datasheets included		
Datasheets are manufacturer originals		
Datasheets for each product included		
Section paragraph and/or Drawing reference on each datasheet		
Product accessories and options identified		
Products organized by paragraph (or alphabetically by brand)		
No photocopies, faxes and other illegible datasheets included		
Shop Drawings included		
Shop drawings accompany this product data submittal.		
This submittal contains product data for one Section only.		

This checklist serves as a simple and abbreviated reminder of the contents and format of the aforementioned submittal. Refer to Section 220503 "Submittals for Plumbing" and each specific Section for additional submittal requirements. Submittals are subject to rejection if this checklist is not accurately completed and provided along with the specified information. Reproduce this checklist and submit with each submittal for each Section.

SECTION 220505 - EXISTING CONDITIONS AND DEMOLITION

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 DESCRIPTION OF WORK

- A. Prior to submitting a bid, the Plumbing Contractor shall perform a detailed walk-through field inspection, to review the existing structures and premises, to determine all existing conditions, equipment/ piping locations, etc. and shall make all necessary allowances for all required Plumbing related demolition and relocation work. This pre-bid inspection by the Plumbing Contractor shall include inspection of all applicable accessible ceiling cavity, areas, etc.
- B. Should the Plumbing Contractor take any exceptions to providing any related demolition or relocation work, such exceptions shall be stated in detail within the Prime Contractor's bid. No subsequent allowance to the contract cost shall be made for any insufficient allowances made by the Plumbing Contractor during bidding which may result from the Plumbing Contractor's failure to visit job site and review drawings.
- C. Demolition related work may not be specifically indicated on drawings, but shall be included under base bid. All Plumbing related demolition, relocation, etc. work, including work described herein, shall be under base bid.
- D. It is not the intent of these contract documents that existing conditions be accurately shown. Existing Plumbing work is shown to a limited extent on drawings and is shown for general planning reference only. Such locations, etc. have been located from portions of contract documents which were prepared for previously installed work (not from "as-builts"). These locations are not guaranteed. The successful Plumbing Contractor shall have access to all available existing building/system plans and specifications.
- E. The existing plumbing systems may be utilized only to the extent indicated herein or on drawings and/or as directed by Owner's representative in field.
- F. Routing of all new plumbing systems in existing buildings shall be approved by Owner's representative prior to installation.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 AFFECT ON ADJACENT OCCUPIED AREAS

- A. Locate, identify, and protect existing Plumbing services passing through demolition areas and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
- B. It is recognized that there may be some systems rendered inactive by demolition, causing disconnection of "downstream" branches, equipment, etc. which serve occupied areas. It shall be the responsibility of the Plumbing Contractor to investigate these types of conditions (for all systems) prior to demolition. Provide all necessary corrective Plumbing work prior to demolition to ensure that such "downstream" work remain permanently active throughout demolition, new construction and after project completion.
- C. All work and system shutdowns shall be carefully coordinated in advance with owner's representative and all affected trades so that normal building activities and other construction trades are minimally affected. All required Plumbing related demolition and/or new construction work, which will affect any and all occupied areas (including those which are located outside the immediate area of project work) shall be performed at special times if/as directed by Owner's representative in field.
- D. All existing systems and components shall remain fully operational in all occupied spaces during all occupied periods.
- E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent finished areas and/or other system components. During cutting and patching operations, protect adjacent installations. Remove protection and barriers after demolition operations are complete.

3.2 WORK IN EXISTING SPACES

- A. General: Care shall be taken when working in existing spaces so as not to damage existing walls and ceilings where work is being performed.
- B. Existing Ceilings: Where work is being performed above ceilings, and the architectural drawings do not indicate ceiling modifications by the General Contractor, it shall be the responsibility of this contractor to remove and replace existing ceilings where work is being performed. In those instances, all repair and installation of new grid, ceiling panels, etc shall be the responsibility of this contractor. Match existing finishes.

- C. Walls & Floors: It shall be the responsibility of this contractor to patch existing walls and floors and match existing finishes where work is being removed or installed and patching is being performed, unless noted otherwise on the architectural drawings.
- D. If asbestos, PCB's, or other hazardous materials are encountered in the course of the work, stop work in the vicinity of such materials and report their presence to the Owner. Owner will arrange for proper removal and disposal of hazardous materials.

3.3 GENERAL DEMOLITION

- A. Provide complete Plumbing demolition as required for all systems throughout all project areas not indicated to be salvaged or saved. Unless specifically noted otherwise on plans or determined otherwise during this contractor's pre-demolition survey, all abandoned existing Plumbing work in the project areas shall be disconnected and removed in its entirety by the Plumbing Contractor. All related work shall comply with the notes specified herein.
- B. Provide demolition work as required to clear and remove all existing Plumbing work to be abandoned and as required to accommodate all new work of all trades. In general, remove existing related piping, control media, etc. back to nearest concealed accessible terminal or take-off "upstream". Extend piping, etc. as required to accommodate new or relocated Plumbing work.
- C. Remove abandoned, inactive and obsolete equipment, piping, etc. Abandoned work embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove all abandoned materials above accessible ceilings.
- D. Perform cutting and patching required for demolition in accordance with the contract documents.
- E. All abandoned and piping shall be removed and capped back to respective sources, even if sources are outside of the confines of the project area. Coordinate all work carefully with Owner prior to beginning any Plumbing demolition work.
- F. All piping, etc. conflicting with construction related work of any and all trades shall be removed and/or relocated by the Plumbing Contractor as necessary and/or as directed by Owner's representative in the field. Plumbing disconnections (and/or reconnections) for equipment to be removed (and/or relocated) shall be by the Plumbing Contractor. This shall apply to all existing Plumbing work whether shown on drawings or not.
- G. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.
- H. Provide new work as required to accommodate relocations, etc. Routing of all new and piping in existing buildings shall be held tight to structure above wherever possible and shall be approved by owner's representative prior to installation.

3.4 DISPOSITION OF REMOVED EQUIPMENT & MATERIALS

- A. Except where specifically noted otherwise herein or on drawings, all Plumbing work shown on new work plans shall be new.
- B. If required to accommodate construction related activities, remove and reinstall any conflicting fixtures, devices or equipment that are to remain.
- C. All abandoned materials removed during demolition and thereafter shall be referred to the Owner's representative for disposal instructions. All materials which the Owner elects to retain shall be neatly stored at the site by the Plumbing Contractor as designated by the Owner's representative. All materials which the Owner elects not to retain shall be disposed of by the Plumbing Contractor in a lawful manner.
- D. All fixtures, devices or equipment designated for salvage (removal and reuse, or for turning over to Owner) shall be disconnected and removed undamaged. Disconnect all pigtails, etc. from equipment terminal points and carefully transport and neatly store same to a protected on-site storage location as directed in field.
- E. Components to be reused shall be cleaned (inside and out) and reinstalled where indicated on drawings. Modify and/or extend related existing ductwork and/or piping as required.
- F. Components turned over to Owner shall be neatly stored as groups by system type.

3.5 PRE-EXISTING CODE VIOLATIONS

- A. All existing work which is accessed and/or used under this project shall be inspected and brought into compliance with current codes and standards by the Plumbing Contractor. This shall apply only to the extent that such work is uncovered in the immediate project areas affected by demolition and/or new construction and only to the limited extent that it applies to pre-existing general installation methods (i.e. a missing hanger/support, a missing seal and other minor incidental work).
- B. If more extensive code or safety violations are discovered by the Plumbing Contractor, they shall be immediately brought to the attention (detailed in writing) of the Owner's representative along with the contractors proposed cost for corrections.

3.6 INTERIM LIFE SAFETY WORK

- A. Provide interim fire protection (sprinkler) work in all demolition and construction areas for full code coverage. Further definition will be provided in field if required.

END OF SECTION 220505

SECTION 220517 - SLEEVES AND SLEEVES SEALS FOR PLUMBING PIPING

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. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.

1.3 SUBMITTALS

- A. General:
 - 1. Comply with Section 22 05 03.00 "Submittals for Plumbing."
- B. Product Data (PD):
 - 1. Product Datasheets for Sleeve Seals.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Galvanized-steel Sheet: 0.0239 inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Install steel pipe sleeves two sizes larger than pipes passing through floors, walls or masonry construction.

2.2 STACK-SLEEVE FITTINGS

- A. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. Metraflex Company (The).
 - 4. Pipeline Seal and Insulator, Inc.
 - 5. Proco Products, Inc.
 - 6. Link-Seal Modular Seals
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Carbon steel.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Presealed Systems.
 - 2. Advance Products & Systems, Inc.
 - 3. CALPICO, Inc.
 - 4. Metraflex Company (The).
 - 5. Pipeline Seal and Insulator, Inc.
 - 6. Proco Products, Inc.
 - 7. Link-Seal Modular Seals
- B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
- B. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
- C. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
- D. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
- E. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
- F. Using grout, seal the space around outside of stack-sleeve fittings.
- G. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade:
 - a. Galvanized-steel-pipe sleeves.
 - 2. Exterior Concrete Walls below Grade:
 - a. Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 3. Concrete Slabs-on-Grade:
 - a. Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 4. Concrete Slabs above Grade:
 - a. Stack-sleeve fittings
 - b. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
 - 5. Interior Partitions:
 - a. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

END OF SECTION 220517

SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

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. Escutcheons.
 - 2. Floor plates.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.

- c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with rough-brass finish.
 - f. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with rough-brass finish.
2. Escutcheons for Existing Piping:
- a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
 - b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - c. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - d. Bare Piping in Unfinished Service Spaces: Split-casting brass type with rough-brass finish.
 - e. Bare Piping in Equipment Rooms: Split-casting brass type with rough-brass finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
- 1. New Piping: One-piece, floor-plate type.
 - 2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 220518

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

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. Liquid-in-glass thermometers.
- 2. Thermowells.
- 3. Dial-type pressure gages.
- 4. Gage attachments.

- B. Related Sections:

- 1. Section 221116 "Domestic Water Piping" for water meters inside the building.

1.3 SUBMITTALS

- A. General:

- 1. Comply with Section 22 05 03.00 "Submittals for Plumbing."

- B. Product Data (PD):

- 1. Liquid-in-glass thermometers.
- 2. Thermowells.
- 3. Dial-type pressure gages.
- 4. Gage attachments.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

- A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:

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

- b. Ashcroft Inc.
 - c. Ernst Flow Industries.
 - d. Marsh Bellofram.
 - e. Miljoco Corporation.
 - f. Nanmac Corporation.
 - g. Noshok.
 - h. Palmer Wahl Instrumentation Group.
 - i. REOTEMP Instrument Corporation.
 - j. Tel-Tru Manufacturing Company.
 - k. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - l. Weiss Instruments, Inc.
 - m. WIKA Instrument Corporation - USA.
 - n. Winters Instruments - U.S.
2. Standard: ASME B40.200.
 3. Case: Cast aluminum; 6-inch nominal size.
 4. Case Form: Back angle unless otherwise indicated.
 5. Tube: Glass with magnifying lens and blue or red organic liquid.
 6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
 7. Window: Glass or plastic.
 8. Stem: Aluminum or brass and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
 9. Connector: 3/4 inch, with ASME B1.1 screw threads.
 10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Type: Stepped shank unless straight or tapered shank is indicated.
4. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
5. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
6. Bore: Diameter required to match thermometer bulb or stem.
7. Insertion Length: Length required to match thermometer bulb or stem.
8. Lagging Extension: Include on thermowells for insulated piping and tubing.
9. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AMETEK, Inc.; U.S. Gauge.
 - b. Ashcroft Inc.
 - c. Ernst Flow Industries.
 - d. Flo Fab Inc.
 - e. Marsh Bellofram.
 - f. Miljoco Corporation.
 - g. Noshok.
 - h. Palmer Wahl Instrumentation Group.
 - i. REOTEMP Instrument Corporation.
 - j. Tel-Tru Manufacturing Company.
 - k. Terice, H. O. Co.
 - l. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - m. Weiss Instruments, Inc.
 - n. WIKA Instrument Corporation - USA.
 - o. Winters Instruments - U.S.
2. Standard: ASME B40.100.
3. Case: Liquid-filled types; cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade C, plus or minus 3 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass ball, with NPS 1/4, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending a minimum of one-third of pipe diameter and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- G. Install valve and snubber in piping for each pressure gage for fluids.
- H. Install thermometers in the following locations:
 - 1. Inlet and outlet of each water heater.
- I. Install pressure gages in the following locations:
 - 1. Building water service entrance into building.

3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each domestic water heater shall be the following:
 - 1. Liquid-in-glass thermometers.

- B. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Cold-Water Piping: 0 to 150 deg F
- B. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F.

3.6 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at discharge of each water service into building shall be:
 - 1. Liquid-filled, direct-mounted, metal case.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Water Service Piping: 0 to 160 psi.
- B. Scale Range for Domestic Water Piping: 0 to 160 psi.

END OF SECTION 220519

SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

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. Bronze ball valves.
- 2. Bronze swing check valves.

- B. The requirements of the Lead-Free Law S.3874 are currently being enforced in all areas in the United States as of January 4, 2014. Where the Law pertains, it is the contractor's responsibility to provide lead-free products as mandated by the Law and as required/interpreted by the Authority Having Jurisdiction. This requirement will be enforced by inspectors at the time of inspection, not based on the day that the project was permitted.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. PTFE: Polytetrafluoroethylene.
- E. NRS: Nonrising stem.
- F. OS&Y: Outside screw and yoke.
- G. RS: Rising stem.

1.4 SUBMITTALS

- A. General:

- 1. Comply with Section 22 05 03.00 "Submittals for Plumbing."

B. Product Data (PD):

1. Provide product datasheets for all valves.

C. Closeout Submittals (CO):

1. Provide operation and maintenance manuals for all valves.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set ball and plug valves open to minimize exposure of functional surfaces.
4. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
 - 1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
- E. Valve-End Connections:
 - 1. Flanged: With flanges according to ASME B16.1 for iron valves.
 - 2. Grooved: With grooves according to AWWA C606.
 - 3. Solder Joint: With sockets according to ASME B16.18.
 - a. Use solder with melting point below 840 deg F for check valves and below 421 deg F for ball valves
 - 4. Threaded: With threads according to ASME B1.20.1.

2.2 BRONZE BALL VALVES

- A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Valve, Inc.
 - b. Conbraco Industries, Inc.; Apollo Valves.
 - c. Crane Co.; Crane Valve Group; Crane Valves.
 - d. Hammond Valve.
 - e. Lance Valves; a division of Advanced Thermal Systems, Inc.
 - f. Legend Valve.
 - g. Milwaukee Valve Company.
 - h. NIBCO INC.
 - i. Red-White Valve Corporation.
 - j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Bronze.
 - e. Seats: PTFE or TFE.
 - f. Stem: Bronze.
 - g. Ball: Chrome-plated brass.
 - h. Port: Full.
- B. Three-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. DynaQuip Controls.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Red-White Valve Corporation.

2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Three piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE or TFE.
 - g. Stem: Bronze.
 - h. Ball: Chrome-plated brass.
 - i. Port: Full.

2.3 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Valve, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Division.
 - e. Hammond Valve.
 - f. Kitz Corporation.
 - g. Milwaukee Valve Company.
 - h. NIBCO INC.
 - i. Powell Valves.
 - j. Red-White Valve Corporation.
 - k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - l. Zy-Tech Global Industries, Inc.

2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 DOMESTIC WATER VALVE SCHEDULE

- A. Isolation/Control Valves

1. All valves installed in domestic water piping 3” and smaller shall be ball valves.
 - a. Ball Valves - 1 Inch and Smaller: 2-piece body, 600 psi CWP, lead-free dezincification-resistant body, full port, PTFE seats, blowout-proof stem, adjustable packing gland and vinyl-covered steel handle. Provide extended valve stems for valves used on insulated lines. Provide equal to Nibco Series 685-80-LF.
 - b. Ball Valves – 1-1/4 Inch and Larger: 3-piece body, 600 psi CWP, lead-free dezincification-resistant body, full port, PTFE seats, blowout-proof stem, adjustable packing gland and vinyl-covered steel handle. Provide extended valve stems for valves used on insulated lines. Provide equal to Nibco Series 595-Y-LF.

B. Check Valves

1. Swing Check Valves - Class 125, cast bronze body and cap, horizontal swing, Y-pattern, with a bronze disc, and having threaded or solder ends. Provide solder ends for domestic hot and cold water service. Provide equal to Nibco 413-LF.
2. Valves shall be Y-pattern swing-type rated 200 psi non-shock CWP. Body, bonnet, and disc hanger are to be lead-free dezincification-resistant material and PTFE seat disc. Valve ends may be threaded or solder-type. Provide equal to Nibco 413-Y-LF.
3. Provide a check valve immediately downstream of the main water service reduced pressure backflow preventer when a booster pump is installed on the domestic water system.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

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 pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Pipe positioning systems.
8. Equipment supports.

B. Related Sections:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 220516 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
3. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.
4. Where more than one type of material is allowed, the hangers and supports provided shall be rated to support the piping and equipment they are intended to hang or support.

1.5 SUBMITTALS

A. General:

1. Comply with Section 22 05 03.00 "Submittals for Plumbing."

B. Product Data (PD):

1. Provide product datasheets for all hangers and supports.

C. Closeout Submittals (CO):

1. Provide operation and maintenance manuals for all hangers and supports.

1.6 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon or stainless steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon or stainless steel.

C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.
 - c. Flex-Strut Inc.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut Corporation; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - h. Anvil International; a subsidiary of Mueller Water Products Inc.
 - i. Empire Industries, Inc.
 - j. ERICO International Corporation.
 - k. Haydon Corporation; H-Strut Division.
 - l. NIBCO INC.
 - m. PHD Manufacturing, Inc.
 - n. PHS Industries, Inc.
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.

2.4 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Carpenter & Paterson, Inc.
 2. Clement Support Services.
 3. ERICO International Corporation.
 4. National Pipe Hanger Corporation.
 5. PHS Industries, Inc.
 6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 7. Piping Technology & Products, Inc.
 8. Rilco Manufacturing Co., Inc.
 9. Value Engineered Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig or ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless-steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece plastic or stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand:
 - 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 2. Base: Plastic or stainless steel.
 - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand:
 - 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 2. Bases: One or more; plastic.
 - 3. Vertical Members: Two or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.
 - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.8 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.9 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

- G. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- M. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- O. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Clamps shall not project through insulation.
 - b. Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.

- c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
- 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
- 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099113 "Exterior Painting", Section 099123 "Interior Painting" or Section 099600 "High-Performance Coatings."

- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

- S. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

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. Equipment labels.
 - 2. Pipe labels.
 - 3. Valve tags.

1.3 SUBMITTALS

- A. General:
 - 1. Comply with Section 22 05 03.00 "Submittals for Plumbing."
- B. Product Data (PD):
 - 1. Provide product datasheets for all labels, signs, valve tags, and warning tags.
- C. Closeout Submittals (CO):
 - 1. Provide operation and maintenance manuals for all plumbing components, fixtures, valves, and equipment.
 - 2. Equipment-Label Schedule: Include a listing of all equipment to be labeled and the proposed content for each label.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment-Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater

viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

- G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; pipe size; and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping-system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032 inch thick, with predrilled holes for attachment hardware.
 - 2. Fasteners: Brass beaded chain.
- B. In Microsoft Excel format on CD, provide a spreadsheet listing of all valves utilized for this project which includes the following:
 - 1. Valve number
 - a. Use "XX" for prefix, then number, where "XX" relates to the associated system where applicable:
 - 1) DC Domestic Cold Water.
 - 2) DH Domestic Hot Water.
 - 3) DR Domestic Hot Water Return.
 - 4) For all other systems, use logical naming convention.
 - 2. Piping system associated with.
 - 3. Location of valve (architectural room number).

4. Normal-operating position (open, closed, or modulating).
5. Identify special or unique characteristics (emergency shutoff).
6. Valve-tag schedule shall also be included in operation and maintenance data.

2.5 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 1. Size: 3 by 5-1/4 inches minimum.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Pipe Label Color Schedule:

1. Domestic Cold Water, Hot Water, Hot Water Return, Sanitary, Storm, Sanitary, and Oxygen Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 1. Valve-Tags shall be round, 1-1/2 inches in diameter, with green background and white lettering.

3.5 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 220553

SECTION 220719 - PLUMBING SYSTEMS INSULATION

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

- 1. Domestic cold-water piping.
- 2. Domestic hot and recirculating hot-water piping.
- 3. Exposed sanitary drains, domestic water, domestic hot water, and stops for plumbing fixtures for people with disabilities.

- B. Related Sections:

- 1. Section 220716 "Plumbing Equipment Insulation."

1.3 SUBMITTALS

- A. General:

- 1. Comply with Section 21 05 03.00 "Submittals for Plumbing."

- B. Quality Assurance (QA):

- 1. Provide documentation that shows qualifications and compliance with quality assurance requirements for qualified installer.

- C. Product Data (PD):

- 1. Provide product datasheets for all insulation materials, adhesives, and sealants. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
- 2. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.
- 3. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that product complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Pittsburgh Corning Corporation; Foamglas.
 - b. Owens-Corning Fiberglass Corp.
 - c. Knauf
 - d. CertainTeed.
 - e. Johns Manville.
 - 2. Block Insulation: ASTM C 552, Type I.
 - 3. Special-Shaped Insulation: ASTM C 552, Type III.
 - 4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 - 5. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
 - 6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Aeroflex USA, Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
- G. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fibrex Insulation, Inc.; Coreplus 1200.
 - b. Johns Manville; Micro-Lok.
 - c. Knauf Insulation; 1000-Degree Pipe Insulation.
 - d. Manson Insulation, Inc.; Alley-K.
 - e. Owens Corning; Fiberglass Pipe Insulation.
2. Type I, 850 Deg F (454 Deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. Fiberglass Insulation:

1. Fiberglass piping insulation: ASTM C 547, Class 1
2. Encase pipe fittings insulation with one-piece premolded PVC fitting covers.
3. Vapor Barrier Material: Paper-backed aluminum foil, except as otherwise indicated, strength and permeability rating equivalent to adjoining pipe insulation jacketing.
4. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.
5. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.
6. Manufacturer: Subject to compliance with requirements, provide products of one of the following:
 - a. Armstrong World Industries, Inc.
 - b. Owens-Corning Fiberglass Corp.
 - c. Keene Corp.
 - d. CertainTeed.
 - e. Johns Manville.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. PVC Jacket Adhesive: Compatible with PVC jacket.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 SEALANTS

A. Joint Sealants:

1. Joint Sealants: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Eagle Bridges - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Pittsburgh Corning Corporation; Pittseal 444.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.5 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: White.
 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- C. Metal Jacket:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
 - b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
 - c. RPR Products, Inc.; Insul-Mate.
 2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.

- 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- D. Underground Direct-Buried Jacket: 125-mil-thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Pittsburgh Corning Corporation; Pittwrap.
 - b. Polyguard Products, Inc.; Insulrap No Torch 125.
 - c. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.

2.6 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABI, Ideal Tape Division; 428 AWF ASJ.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
 - c. Compac Corporation; 104 and 105.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABI, Ideal Tape Division; 491 AWF FSK.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - c. Compac Corporation; 110 and 111.
 - d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
 2. Width: 3 inches.
 3. Thickness: 6.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.

7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABI, Ideal Tape Division; 370 White PVC tape.
 - b. Compac Corporation; 130.
 - c. Venture Tape; 1506 CW NS.
 2. Width: 2 inches.
 3. Thickness: 6 mils.
 4. Adhesion: 64 ounces force/inch in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABI, Ideal Tape Division; 488 AWF.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
 - c. Compac Corporation; 120.
 - d. Venture Tape; 3520 CW.
 2. Width: 2 inches.
 3. Thickness: 3.7 mils.
 4. Adhesion: 100 ounces force/inch in width.
 5. Elongation: 5 percent.
 6. Tensile Strength: 34 lbf/inch in width.

2.7 SECUREMENTS

- A. Bands:
1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M; 0.015 inch thick, 1/2 inch wide.
 2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- C. Wire: 0.080-inch nickel-copper alloy.

2.8 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Engineered Brass Company.
 - b. Insul-Tect Products Co.; a subsidiary of MVG Molded Products.
 - c. McGuire Manufacturing.
 - d. Plumberex.
 - e. Truebro; a brand of IPS Corporation.
 - f. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
2. Description: Manufactured plastic wraps for covering plumbing fixture water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Truebro; a brand of IPS Corporation.
 - b. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
 - c. ProFlo
 - d. Plumberex.
2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- 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 Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 - 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 - 2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
 - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.

- B. Where FSK jackets are indicated, install as follows:
 - 1. Draw jacket material smooth and tight.
 - 2. Install lap or joint strips with same material as jacket.
 - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 - 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
 - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
 - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.9 FIELD QUALITY CONTROL

- A. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces.
 - 2. Underground piping conveying unheated fluids.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. Insulation shall be one of the following:
 - a. Cellular Glass: 1 inch thick.
 - b. Flexible Elastomeric: 1/2 inch thick.
 - c. Insulation thicknesses shall be doubled for piping installed in non-conditioned spaces such as boiler rooms, attics, crawl spaces, tunnels, etc.

B. Domestic Hot and Recirculated Hot Water:

1. Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
 - c. Insulation thicknesses shall be doubled for piping installed in non-conditioned spaces such as boiler rooms, attics, crawl spaces, tunnels, etc.

C. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. All Pipe Sizes: Insulation shall be one of the following:
 - a. One-piece PVC, with 1/8" thickness, meeting the standards of ASTM E 84-07 with a flame spread/ 450 smoke index per the building code. Surfaces to be soft, smooth, non-absorbent, easy to clean U/V inhibited, antimicrobial, antifungal properties. Insulator shall have a dual fastening system which consists of fusion bonded Velcro fastener strips for full slit enclosure and tamper resistant, smooth, non-abrasive snap-locking fasteners. PTrap Insulator: Shall have a one-piece design with a universal fit for 1 1/4"-1 1/2" brass or plastic traps, a longer neck area (for longer tailpieces) and a more forgiving girth area (for bulkier plastic DWV Schedule #40 plastic P-Traps w/swivel nut) and shall have drainage at lowest point to prevent condensation and/or leakage build up. Valve and Supply Insulator: Shall have a one-piece design with a universal fit over valve handles and brass, plastic or metal braided supplies and connectors and shall be able to flexcurl to a minimum of 360 degrees with a full slit closure for total compliance. Off-Set Insulator: Shall have a one-piece design with a universal fit and shall fit inside of P-trap insulator tailpiece area.
 - b. Soft, resilient molded vinyl, with 1/8" minimum constant nominal wall thickness with internal ribs, UV resistant, which meets the requirements of ASTM D-635 burning characteristics.
 - c. Insulation thicknesses shall be doubled for piping installed in non-conditioned spaces such as boiler rooms, attics, crawl spaces, tunnels, etc.

END OF SECTION 220719

SECTION 221113 - FACILITY WATER DISTRIBUTION PIPING

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 water-distribution piping and related components outside the building for:
 - 1. Water service mains

1.3 DEFINITIONS

- A. EPDM: Ethylene propylene diene monomer.

1.4 SUBMITTALS

- A. General:

- 1. Comply with Section 22 05 03.00 "Submittals for Plumbing."

- B. Product Data (PD):

- 1. Provide product datasheets for all piping, fittings, and solvents.

- C. Shop Drawings (SD):

- 1. Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.
 - 2. Wiring Diagrams: Power, signal, and control wiring for alarms.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:

- 1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
 - 2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.

3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.
- E. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.
- F. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
- G. NSF Compliance:
 1. Comply with NSF 14 for plastic potable-water-service piping. Include marking "NSF-pw" on piping.
 2. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
 1. Ensure that valves are dry and internally protected against rust and corrosion.
 2. Protect valves against damage to threaded ends and flange faces.
 3. Set valves in best position for handling. Set valves closed to prevent rattling.
- B. During Storage: Use precautions for valves, including fire hydrants, according to the following:
 1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
 2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
- C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
- D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

- E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
- F. Protect flanges, fittings, and specialties from moisture and dirt.
- G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:
 - 1. Notify Architect, Construction Manager, and Owner no fewer than seven days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of water-distribution service without Architect's written permission.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper.
 - 1. Copper, Solder-Joint Fittings: Soldered joints shall be made in accordance with the methods of ASTM B828. All cut tube ends shall be reamed to the full inside diameter of the tube end. All joint surfaces shall be cleaned. A flux conforming to ASTM B813 shall be applied. The joint shall be soldered with a solder conforming to ASTM B32. The joining shall be made with lead-free (with a chemical composition equal to or less than 0.2 percent lead) solders and fluxes.
 - 2. Brazed Joints: All joint surfaces shall be cleaned. An approved flux shall be applied where required. The joint shall be brazed with a filler material conforming to AWS A5.8.
 - 3. Flared joints: Flared joints shall be made by a tool designed for that operation.
- B. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
- C. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.2 DUCTILE-IRON PIPE AND FITTINGS

- A. 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.

B. Refer to Section 330500 "Common Work Results for Utilities" for commonly used joining materials.

C. Brazing Filler Metals: AWS A5.8, BCuP Series.

2.3 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Tubular-Sleeve Pipe Couplings:

1. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers and products. Retain one of first two subparagraphs and list of manufacturers below. See Section 016000 "Product Requirements."
2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cascade Waterworks Manufacturing.
 - b. Dresser, Inc.; Dresser Piping Specialties.
 - c. Ford Meter Box Company, Inc. (The); Pipe Products Div.
 - d. Hays Fluid Controls; a division of ROMAC Industries Inc.
 - e. JCM Industries.
 - f. Smith-Blair, Inc.
 - g. Viking Johnson.
3. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.
 - a. Standard: AWWA C219.
 - b. Gasket Material: Natural or synthetic rubber.
 - c. Pressure Rating: 200 psig minimum.
 - d. Metal Component Finish: Corrosion-resistant coating or material.

C. Split-Sleeve Pipe Couplings:

1. Description: Metal, bolted, split-sleeve-type, reducing or transition coupling with sealing pad and closure plates, O-ring gaskets, and bolt fasteners.
 - a. Standard: AWWA C219.
 - b. Sleeve Dimensions: Of thickness and width required to provide pressure rating.
 - c. Gasket Material: O-rings made of EPDM rubber, unless otherwise indicated.
 - d. Pressure Rating: 200 psig minimum.
 - e. Metal Component Finish: Corrosion-resistant coating or material.

D. Flexible Connectors:

1. Nonferrous-Metal Piping: Bronze hose covered with bronze wire braid; with copper-tube, pressure-type, solder-joint ends or bronze flanged ends brazed to hose.
2. Ferrous-Metal Piping: Stainless-steel hose covered with stainless-steel wire braid; with ASME B1.20.1, threaded steel pipe nipples or ASME B16.5, steel pipe flanges welded to hose.

E. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:
 - a. Description:
 - 1) Standard: ASSE 1079.
 - 2) Revise pressure rating and temperature in first subparagraph below to suit Project, or insert other options for specific applications.
 - 3) Pressure Rating: 250 psig.
 - 4) End Connections: Solder-joint copper alloy and threaded ferrous.
3. Dielectric Flanges:
 - a. Description:
 - 1) Standard: ASSE 1079.
 - 2) Factory-fabricated, bolted, companion-flange assembly.
 - 3) Revise pressure rating in first subparagraph below to suit Project, or insert other options for specific applications.
 - 4) Pressure Rating: 175 psig.
 - 5) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
4. Dielectric-Flange Insulating Kits:
 - a. Description:
 - 1) Non-conducting materials for field assembly of companion flanges.
 - 2) Revise pressure rating in first subparagraph below to suit Project, or insert other options for specific applications.
 - 3) Pressure Rating: 175 psig.
 - 4) Gasket: Neoprene or phenolic.
 - 5) Bolt Sleeves: Phenolic or polyethylene.
 - 6) Washers: Phenolic with steel backing washers.
5. Dielectric Nipples:
 - a. Description:
 - 1) Standard: IAPMO PS 66
 - 2) Electroplated steel nipple. complying with ASTM F 1545.
 - 3) Revise pressure rating and temperature in first subparagraph below to suit Project, or insert other options for specific applications.
 - 4) Pressure Rating: 300 psig.
 - 5) End Connections: Male threaded or grooved.

F. Corrosion-protection piping encasement:

1. Encasement for Underground Metal Piping:
 - a. Standards: ASTM A 674 or AWWA C105.
 - b. Form: Sheet or tube.
 - c. Retain one of first three subparagraphs below.
 - d. Material: LLDPE film of 0.008-inch minimum thickness.
 - e. Material: LLDPE film of 0.008-inch minimum thickness, or high-density, cross-laminated PE film of 0.004-inch minimum thickness.
 - f. Material: High-density, cross-laminated PE film of 0.004-inch minimum thickness.

2.4 GATE VALVES

A. AWWA, Cast-Iron Gate Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American AVK Co.; Valves & Fittings Div.
 - b. American Cast Iron Pipe Co.; American Flow Control Div.
 - c. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
 - d. Crane Co.; Crane Valve Group; Stockham Div.
 - e. East Jordan Iron Works, Inc.
 - f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
 - g. McWane, Inc.; Kennedy Valve Div.
 - h. McWane, Inc.; M & H Valve Company Div.
 - i. McWane, Inc.; Tyler Pipe Div.; Utilities Div.
 - j. Mueller Co.; Water Products Div.
 - k. NIBCO INC.
 - l. U.S. Pipe and Foundry Company.
2. Nonrising-Stem, Resilient-Seated Gate Valves:
 - a. Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
 - 1) Standard: AWWA C509.
 - 2) Minimum Pressure Rating: 200 psig.
 - 3) End Connections: Mechanical joint.
 - 4) Interior Coating: Complying with AWWA C550.
 - b. OS&Y, Rising-Stem, Resilient-Seated Gate Valves:
 - c. Description: Cast- or ductile-iron body and bonnet, with bronze or gray- or ductile-iron gate, resilient seats, and bronze stem.
 - 1) Standard: AWWA C509.
 - 2) Minimum Pressure Rating: 200 psig.
 - 3) End Connections: Flanged.

2.5 CHECK VALVES

A. AWWA Check Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American AVK Co.; Valves & Fittings Div.
 - b. American Cast Iron Pipe Co.; American Flow Control Div.
 - c. APCO Williamette; Valve and Primer Corporation.
 - d. Crane Co.; Crane Valve Group; Crane Valves.
 - e. Crane Co.; Crane Valve Group; Stockham Div.
 - f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
 - g. McWane, Inc.; Kennedy Valve Div.
 - h. McWane, Inc.; M & H Valve Company Div.
 - i. Mueller Co.; Water Products Div.
 - j. NIBCO INC.
 - k. Watts Water Technologies, Inc.
2. Description: Swing-check type with resilient seat. Include interior coating according to AWWA C550 and ends to match piping.
 - a. Standard: AWWA C508.
 - b. Pressure Rating: 175 psig.

2.6 CORPORATION VALVES AND CURB VALVES

A. Manufacturers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Amcast Industrial Corporation; Lee Brass Co.
 - b. Ford Meter Box Company, Inc. (The); Pipe Products Div.
 - c. Jones, James Company.
 - d. Master Meter, Inc.
 - e. McDonald, A. Y. Mfg. Co.
 - f. Mueller Co.; Water Products Div.
 - g. Red Hed Manufacturing & Supply.

B. Service-Saddle Assemblies: Comply with AWWA C800. Include saddle and valve compatible with tapping machine.

1. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
2. Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.
3. Retain subparagraph below if utility company requires multiple connections.

4. Manifold: Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.
- C. Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.
- D. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches in diameter.
 1. Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

2.7 BACKFLOW PREVENTERS

- A. Double-Check, Detector-Assembly Backflow Preventers:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Ames Fire & Waterworks; a division of Watts Regulator Co.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; SPX Valves & Controls.
 - d. Watts Water Technologies, Inc.
 - e. Wilkins; a Zurn company.
 2. Standards: ASSE 1048 and UL listed or FMG approved.
 3. Operation: Continuous-pressure applications.
 4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
 5. End Connections: Flanged.
 6. Accessories:
 - a. Valves: UL 262, FMG-approved, OS&Y gate type with flanged ends on inlet and outlet.
 - b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.
- B. Backflow Preventer Test Kits:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Conbraco Industries, Inc.
 - b. FEBCO; SPX Valves & Controls.
 - c. Flomatic Corporation.
 - d. Watts Water Technologies, Inc.
 - e. Wilkins; a Zurn company.

2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Refer to Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING SCHEDULE

- A. Provide products for water distribution piping as required by the Authority Having Jurisdiction. If no procedures are stipulated by the Authority Having Jurisdiction, then provide products and install as described below.
- B. Underground Domestic Water-Service Piping from Street Main or tap of Combined Domestic Water-Service/Fire Service Main piping through meter crock/vault shall be:
 1. ½" through 2":
 - a. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper, with wrought-copper solder-joint fittings and brazed joints.
 2. 3" and larger:
 - a. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed joints.
- C. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
- D. Do not use flanges or unions for underground piping.
- E. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

3.3 VALVE APPLICATIONS

- A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, non-rising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.
 1. Use the following for valves in vaults and aboveground:
 - a. Gate Valves, NPS 2 and Smaller: Bronze, stem.
 - b. Gate Valves, NPS 3 and Larger: Cast iron, OS&Y rising stem, resilient seated.
 - c. Check Valves: swing type.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. See Section 330500 "Common Work Results for Utilities" for piping-system common requirements.

3.5 PIPING INSTALLATION

- A. Make connections larger than NPS 2 with tapping machine according to the following:
 - 1. Install tapping sleeve and tapping valve according to MSS SP-60.
 - 2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
 - 3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
 - 4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.

- B. Make connections NPS 2 and smaller with drilling machine according to the following:
 - 1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
 - 2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
 - 3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
 - 4. Install corporation valves into service-saddle assemblies.
 - 5. Install manifold for multiple taps in water main.
 - 6. Install curb valve in water-service piping with head pointing up and with service box.

- C. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

- D. Bury piping with depth of cover over top at least 48 inches, with top at least below level of maximum frost penetration.

- E. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.

- F. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
 - 1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.

- G. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

3.6 JOINT CONSTRUCTION

- A. See Section 330500 "Common Work Results for Utilities" for basic piping joint construction.
- B. Make pipe joints according to the following:
 - 1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
 - 2. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 - a. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.
 - b. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, flange kits, or nipples.
 - c. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.7 ANCHORAGE INSTALLATION

- A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
 - 1. Concrete thrust blocks.
 - 2. Locking mechanical joints.
 - 3. Set-screw mechanical retainer glands.
 - 4. Bolted flanged joints.
 - 5. Heat-fused joints.
 - 6. Pipe clamps and tie rods.
- B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
 - 1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
 - 2. Fire-Service-Main Piping: According to NFPA 24.
- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.8 VALVE INSTALLATION

- A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
- B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.
- C. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.

- D. UL/FMG, Valves Other Than Gate Valves: Comply with NFPA 24.
- E. MSS Valves: Install as component of connected piping system.
- F. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.
- G. Pressure-Reducing Valves: Install in vault between shutoff valves. Install full-size valved bypass where allowed by the water utility company.
- H. Relief Valves: Comply with AWWA C512. Install aboveground with shutoff valve on inlet.

3.9 CONNECTIONS

- A. See Section 330500 "Common Work Results for Utilities" for piping connections to valves and equipment.
- B. Connect water-distribution piping to utility water main or existing water main. Use tapping sleeve and tapping valve or service clamp and corporation valve as required by the water utility company.
- C. Connect water-distribution piping to interior piping.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.10 FIELD QUALITY CONTROL

- A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- B. Hydrostatic Tests:
 - 1. The entire water distribution system shall be tested and proven tight under air or water pressure of fifty percent more than the maximum pressure of each system or 100 psig whichever is greater for a time as determined by the Authority Having Jurisdiction but not less than 2 hours.
 - 2. Combination domestic and fire protection service piping shall be tested and proven under a water pressure of 200 psig for two hours.

3. Perform all systems tests in the presence of the Authority Having Jurisdiction and the Owner. Notify the Owner of all systems tests at least 48 hours in advance.
4. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig. Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

C. Prepare reports of testing activities.

3.11 IDENTIFICATION

- A. Install continuous underground, detectable, warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 "Earth Moving."

3.12 CLEANING

A. Clean and disinfect water-distribution piping as follows:

1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction
3. or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
 - a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
 - b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
 - c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 221113

SECTION 221116 - DOMESTIC WATER PIPING

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. Under-building-slab water pipes, tubes, and fittings.
2. Aboveground domestic water pipes, tubes, and fittings inside buildings.

B. Related Requirements:

1. Section 221113 "Facility Water Distribution Piping" for water-service piping outside the building from source to the point where water-service piping enters the building.

1.3 SUBMITTALS

A. General:

1. Comply with Section 22 05 03.00 "Submittals for Plumbing."

B. Product Data (PD):

1. Provide product datasheets for all piping, fittings, and solvents.

1.4 FIELD CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Architect, Construction Manager, and Owner no fewer than seven days in advance of proposed interruption of water service.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
- B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- E. Copper Unions:
 - 1. MSS SP-123.
 - 2. Cast-copper-alloy, hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal seating surfaces.
 - 4. Solder-joint or threaded ends.
- F. Copper Pressure-Seal-Joint Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Elkhart Products Corporation.
 - b. NIBCO Inc.
 - c. Viega.
 - 2. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
 - 3. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cascade Waterworks Manufacturing.
 - b. Dresser, Inc.; Piping Specialties Products.
 - c. Ford Meter Box Company, Inc. (The).
 - d. JCM Industries.
 - e. Romac Industries, Inc.
 - f. Smith-Blair, Inc.; a Sensus company.
 - g. Viking Johnson.

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
 - b. Central Plastics Company.
 - c. Hart Industries International, Inc.
 - d. Jomar International.
 - e. Matco-Norca.
 - f. McDonald, A. Y. Mfg. Co.
 - g. Watts; a division of Watts Water Technologies, Inc.
 - h. Wilkins; a Zurn company.
2. Standard: ASSE 1079.
3. Pressure Rating: 125 psig minimum at 180 deg F
4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
 - b. Central Plastics Company.
 - c. Matco-Norca.
 - d. Watts; a division of Watts Water Technologies, Inc.
 - e. Wilkins; a Zurn company.
2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 125 psig minimum at 180 deg F.
5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
2. Nonconducting materials for field assembly of companion flanges.
3. Pressure Rating: 150 psig.
4. Gasket: Neoprene or phenolic.
5. Bolt Sleeves: Phenolic or polyethylene.
6. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Elster Perfection Corporation.
 - b. Grinnell Mechanical Products; Tyco Fire Products LP.
 - c. Matco-Norca.
 - d. Precision Plumbing Products, Inc.
 - e. Victaulic Company.
2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F 1545.
4. Pressure Rating and Temperature: 300 psig at 225 deg F.
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."
- E. Install shutoff valve immediately upstream of each dielectric fitting.
- F. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

- G. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- H. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- I. Install piping to permit valve servicing.
- J. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- K. Install piping free of sags and bends.
- L. Install fittings for changes in direction and branch connections.
- M. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- N. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."
- O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
- F. Push-on Joints for Copper Tubing: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.
- G. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- H. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
 2. Fittings for NPS 2 and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.5 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings, nipples, or unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, flange kits, or nipples.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 - 6. NPS 6: 10 feet with 5/8-inch rod.
 - 7. NPS 8: 10 feet with 3/4-inc rod.
- E. Install supports for vertical copper tubing every 10 feet.
- F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4and Smaller: 84 incheswith 3/8-inch rod.
 - 2. NPS 1-1/2: 108 inches with 3/8-inchrod.
 - 3. NPS 2: 10 feet with 3/8-inch rod.
 - 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 - 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
 - 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 - 7. NPS 6: 12 feet with 3/4-inch rod.
 - 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- G. Install supports for vertical steel piping every 15 feet.

- H. Install supports for vertical stainless-steel piping every 15 feet.
- I. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - 2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
 - 3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Piping Inspections:
 - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.

- 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
 - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
2. Piping Tests:
- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - f. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.10 ADJUSTING

- A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
 2. Open shutoff valves to fully open position.
 3. Open throttling valves to proper setting.
 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
 - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- B. Clean non-potable domestic water piping as follows:
 - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - 2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Under-building-slab, domestic water, building-service piping shall be:

1. Hard copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
2. Mechanical-joint, ductile-iron pipe; standard-pattern or compact-pattern, mechanical-joint fittings; and mechanical joints.

D. Under-building-slab, domestic water piping shall be:

1. Hard copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.

E. Aboveground domestic water piping shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and soldered joints.

3.13 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

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. Vacuum breakers.
 - 2. Backflow preventers.
 - 3. Balancing valves.
 - 4. Strainers.
 - 5. Hose bibbs.
 - 6. Wall hydrants.
 - 7. Drain valves.
 - 8. Water-hammer arresters.
 - 9. Trap-seal primer valves.

1.3 SUBMITTALS

- A. General:
 - 1. Comply with Section 22 05 03.00 "Submittals for Plumbing."
- B. Product Data (PD):
 - 1. Provide product datasheets for all:
 - a. Vacuum breakers.
 - b. Backflow preventers.
 - c. Balancing valves.
 - d. Strainers.
 - e. Hose bibbs.
 - f. Wall hydrants.
 - g. Drain valves.
 - h. Water-hammer arresters.
 - i. Trap-seal primer valves.
- C. Closeout Submittals (CO):
 - 1. Provide operation and maintenance manuals for all:
 - a. Vacuum breakers.

- b. Backflow preventers.
- c. Balancing valves.
- d. Strainers.
- e. Hose bibbs.
- f. Wall hydrants.
- g. Drain valves.
- h. Water-hammer arresters.
- i. Trap-seal primer valves.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 61 and NSF 14. Mark "NSF-pw" on plastic piping components.
 - 1. Bronze swing check valves.

- A. The requirements of the Lead-Free Law S.3874 are currently being enforced in California, Vermont, and Delaware, and will go into effect for all areas in the United States on January 4, 2014. Where the Law pertains, it is the contractor's responsibility to provide lead-free products as mandated by the Law and as required/interpreted by the Authority Having Jurisdiction. This requirement will be enforced by inspectors at the time of inspection, not based on the day that the project was permitted.

2.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
 - b. Cash Acme; a division of Reliance Worldwide Corporation.
 - c. Conbraco Industries, Inc.
 - d. FEBCO; a division of Watts Water Technologies, Inc.
 - e. Rain Bird Corporation.
 - f. Toro Company (The); Irrigation Div.
 - g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - h. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Rough bronze.

B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Arrowhead Brass Products.
 - b. Cash Acme; a division of Reliance Worldwide Corporation.
 - c. Conbraco Industries, Inc.
 - d. Legend Valve.
 - e. MIFAB, Inc.
 - f. Prier Products, Inc.
 - g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - h. Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - i. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
 - j. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1011.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

C. Pressure Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; a division of Watts Water Technologies, Inc.
 - d. Flomatic Corporation.
 - e. Toro Company (The); Irrigation Div.
 - f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - g. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle third of flow range.
5. Accessories:
 - a. Valves: Ball type, on inlet and outlet.

2.4 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; a division of Watts Water Technologies, Inc.
 - d. Flomatic Corporation.
 - e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - f. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Accessories:
 - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
 - b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
 - c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Dual-Check-Valve Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cash Acme; a division of Reliance Worldwide Corporation.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; a division of Watts Water Technologies, Inc.
 - d. Flomatic Corporation.
 - e. Ford Meter Box Company, Inc. (The).
 - f. Honeywell International Inc.
 - g. Legend Valve.
 - h. McDonald, A. Y. Mfg. Co.
 - i. Mueller Co. Ltd.; a subsidiary of Mueller Water Products Inc.
 - j. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - k. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1024.
3. Operation: Continuous-pressure applications.
4. Body: Bronze with union inlet.

C. Hose-Connection Backflow Preventers:

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

- b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - c. Woodford Manufacturing Company; a division of WCM Industries, Inc.
- 2. Standard: ASSE 1052.
 - 3. Outlet Size: Garden-hose thread complying with ASME B1.20.7.

2.5 BALANCING VALVES

A. Memory-Stop Balancing Valves:

- 1. Balancing valves shall be equal to Red-White Valve Corporation model 9517AB (NPT) or model 9519 (solder). Valve shall have brass body, globe valve regulation and isolation properties, fixed orifice design for precise measurement, integral memory stop to ensure repeatable setting, full shutoff without affecting memory settings, high and low pressure metering points, precision indicator windows, rugged top set hand-wheel assembly, pressure rating of 300 psi, and temperature rating of 15 deg. F to 260 deg. F.
- 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Conbraco Industries, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Div.
 - e. Hammond Valve.
 - f. Milwaukee Valve Company.
 - g. NIBCO Inc.
 - h. Red-White Valve Corp.

2.6 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

- 1. Pressure Rating: 125 psig minimum unless otherwise indicated.
- 2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
- 3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
- 4. Screen: Stainless steel with round perforations unless otherwise indicated.
- 5. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.020 inch.
 - b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
 - c. Strainers NPS 5 and Larger: 0.10 inch.
- 6. Drain: Pipe plug.

2.7 HOSE BIBBS

A. Hose Bibbs:

1. Hose bibbs shall be equal to Woodford Model 24P wall faucet.
2. Where applicable and possible, install all hose bibbs 24"-30" above finish floor to allow filling of mop bucket without hose.
3. Furnish to Owner, with receipt, one valve key for each key operated wall hydrant installed.
4. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Prier Products, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Tyler Pipe; Wade Div.
 - f. Watts Drainage Products.
 - g. Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - h. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
 - i. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.

B. Nonfreeze Wall Hydrants:

1. Wall hydrants shall be equal to Woodford Model B-67 wall hydrant with chrome finish on brass casting with box and hinged, door. Conceal within interior partitions
2. Furnish to Owner, with receipt, one valve key for each key operated wall hydrant installed.
3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Prier Products, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Tyler Pipe; Wade Div.
 - f. Watts Drainage Products.
 - g. Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - h. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
 - i. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.

C. Vacuum Breaker Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Arrowhead Brass Products.
 - b. Mansfield Plumbing Products LLC.
 - c. McDonald, A. Y. Mfg. Co.
 - d. Prier Products, Inc.
 - e. Smith, Jay. R. Mfg. Co.; Division of Smith Industries, Inc.
 - f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - g. Woodford Manufacturing Company; a division of WCM Industries, Inc.

- h. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
- 2. Standard: ASSE 1019, Type A or Type B.
- 3. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
- 4. Classification: Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
- 5. Pressure Rating: 125 psig.
- 6. Operation: Loose key.
- 7. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
- 8. Inlet: NPS 3/4.
- 9. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.8 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

- 1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
- 2. Pressure Rating: 400-psig minimum CWP.
- 3. Size: NPS 3/4.
- 4. Body: Copper alloy.
- 5. Ball: Chrome-plated brass.
- 6. Seats and Seals: Replaceable.
- 7. Handle: Vinyl-covered steel.
- 8. Inlet: Threaded or solder joint.
- 9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Stop-and-Waste Drain Valves:

- 1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
- 2. Pressure Rating: 200-psig minimum CWP or Class 125.
- 3. Size: NPS 3/4.
- 4. Body: Copper alloy or ASTM B 62 bronze.
- 5. Drain: NPS 1/8 side outlet with cap.

2.9 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AMTROL, Inc.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Precision Plumbing Products, Inc.
 - e. Sioux Chief Manufacturing Company, Inc.

- f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - g. Tyler Pipe; Wade Div.
 - h. Watts Drainage Products.
 - i. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
2. Standard: ASSE 1010 or PDI-WH 201.
 3. Type: Metal bellows or copper tube with piston.
 4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.10 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. MIFAB, Inc.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- B. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.

- C. Install balancing valves in locations where they can easily be adjusted.
- D. Install water-hammer arresters in water piping according to PDI-WH 201.
- E. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.
- F. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

3.2 CONNECTIONS

- A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Pressure vacuum breakers.
 - 2. Intermediate atmospheric-vent backflow preventers.
 - 3. Reduced-pressure-principle backflow preventers.
 - 4. Supply-type, trap-seal primer valves.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test each pressure vacuum breaker, reduced-pressure-principle backflow preventer, double-check, and all backflow-prevention assemblies according to authorities having jurisdiction and the device's reference standard.
- B. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.

- B. Set field-adjustable flow set points of balancing valves.

END OF SECTION 221119

SECTION 221316 - SANITARY WASTE AND VENT PIPING

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. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.

1.3 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
 - 2. Waste, Force-Main Piping: 100 psig.

1.4 SUBMITTALS

- A. General:
 - 1. Comply with Section 22 05 03.00 "Submittals for Plumbing."
- B. Product Data (PD):
 - 1. Provide product datasheets for all piping, fittings.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect, Construction Manager, and Owner no fewer than seven days in advance of proposed interruption of sanitary waste service.
 2. Do not proceed with interruption of sanitary waste service without Architect's written permission.
- B. Where new sanitary sewers are required to be connected to existing sewers, it is the contractor's responsibility to verify the location, size, invert elevation, condition, and they shall verify that the existing sewer is indeed a sanitary sewer before any work is done. Provide all necessary camera/scoping as necessary. If there is any need for concern, if it is determined that the existing sewer is not a sanitary sewer or not connected to a sanitary sewer, if the condition of the existing sewer is not viable for re-use, or any other condition that would not allow the proper functioning of the new sewer, the contractor shall notify the engineer in writing immediately via RFI and wait for direction before proceeding.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service class. All cast iron soil pipe and fittings shall be certified NSF and shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute.
- B. Gaskets: ASTM C 564, rubber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888, ASTM A 74, or CISPI 301. Fittings shall be cast iron conforming to ASME B16.4, ASME B16.12, ASTM A 74, ASTM A 888 or CISPI 301. All cast iron soil pipe and fittings shall be certified NSF and shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute.
- B. Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ANACO-Husky.
 - b. Dallas Specialty & Mfg. Co.
 - c. Fernco Inc.
 - d. Matco-Norca, Inc.

- e. MIFAB, Inc.
 - f. Mission Rubber Company; a division of MCP Industries, Inc.
 - g. Stant.
 - h. Tyler Pipe.
 - i. Ideal Tridon
2. Standards: ASTM C 1277 or CISPI 310. All couplings shall be certified NSF and certified to be tested according to ASTM C 1563..
 3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Shielded, Non-pressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Cascade Waterworks Mfg. Co.
 - 2) Mission Rubber Company; a division of MCP Industries, Inc.
 - 3) Dresser, Inc.
 - 4) EBAA Iron, Inc.
 - 5) JCM Industries, Inc.
 - 6) Romac Industries, Inc.
 - 7) Smith-Blair, Inc.; a Sensus company.
 - 8) The Ford Meter Box Company, Inc.
 - 9) Viking Johnson.
 - b. Standard: ASTM C 1460.
 - c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
4. Pressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Cascade Waterworks Mfg. Co.
 - 2) Dresser, Inc.
 - 3) EBAA Iron, Inc.
 - 4) JCM Industries, Inc.
 - 5) Romac Industries, Inc.
 - 6) Smith-Blair, Inc.; a Sensus company.
 - 7) The Ford Meter Box Company, Inc.

- 8) Viking Johnson.
- b. Standard: AWWA C219.
- c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
- d. Center-Sleeve Material: Manufacturer's standard.
- e. Gasket Material: Natural or synthetic rubber.
- f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Capitol Manufacturing Company.
 - 2) Central Plastics Company.
 - 3) Hart Industries International, Inc.
 - 4) Jomar International Ltd.
 - 5) Matco-Norca, Inc.
 - 6) McDonald, A. Y. Mfg. Co.
 - 7) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 8) Wilkins; a Zurn company.
 - b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Pressure Rating: 125 psig minimum at 180 deg F.
 - 3) End Connections: Solder-joint copper alloy and threaded ferrous.
3. Dielectric Flanges:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Capitol Manufacturing Company.
 - 2) Central Plastics Company.
 - 3) Matco-Norca, Inc.
 - 4) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 5) Wilkins; a Zurn company.
 - b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Factory-fabricated, bolted, companion-flange assembly.
 - 3) Pressure Rating: 125 psig minimum at 180 deg F.
 - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
4. Dielectric-Flange Insulating Kits:

- a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Advance Products & Systems, Inc.
 - 2) Calpico, Inc.
 - 3) Central Plastics Company.
 - 4) Pipeline Seal and Insulator, Inc.
 - b. Description:
 - 1) Nonconducting materials for field assembly of companion flanges.
 - 2) Pressure Rating: 150 psig.
 - 3) Gasket: Neoprene or phenolic.
 - 4) Bolt Sleeves: Phenolic or polyethylene.
 - 5) Washers: Phenolic with steel backing washers.
5. Dielectric Nipples:
- a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Elster Perfection.
 - 2) Grinnell Mechanical Products.
 - 3) Matco-Norca, Inc.
 - 4) Precision Plumbing Products, Inc.
 - 5) Victaulic Company.
 - b. Description:
 - 1) Standard: IAPMO PS 66
 - 2) Electroplated steel nipple.
 - 3) Pressure Rating: 300 psig at 225 deg F.
 - 4) End Connections: Male threaded or grooved.
 - 5) Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving" and Section 220500 "Common Work Results for Plumbing".

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- L. Collect vent piping where practical so roof will be penetrated a minimum number of times. Vent sizes and heights above roof shall be per the Plumbing Code in force. Vents penetrating roofs shall be flashed with 4 lb. sheet lead. Vents shall not be terminated within ten feet of any outside air intakes, windows, or door openings.
- M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- N. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

- P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
 - 1. Cast iron coupling for joining hubless cast iron pipe shall consist of neoprene gasket produced and labeled as ASTM C 564, cast iron clamps produced and labeled as ASTM A 48 and stainless steel bolts and nuts produced and labeled as ANSI B18.2.1 and ANSI B18.2.2. Neoprene gaskets shall be produced and labeled as ASTM C 564-70.

3.4 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in OD's.
 - 2. In Drainage Piping: Shielded, nonpressure transition couplings.
 - 3. In Aboveground Force Main Piping: Fitting-type transition couplings.
 - 4. In Underground Force Main Piping:
 - a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
 - b. NPS 2 and Larger: Pressure transition couplings.
- B. Dielectric Fittings:
 - 1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 - 2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.
 - 3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, flange kits, or nipples.
 - 4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
 6. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 2. NPS 3: 60 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
 5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3: 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
- H. Install supports for vertical steel piping every 15 feet.

- I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 3. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
 - 5. NPS 6: 10 feet with 5/8-inch rod.
- J. Install supports for vertical copper tubing every 10 feet.
- K. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 - 5. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. Make connections according to the following unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 - 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 6. Prepare reports for tests and required corrective action.

3.8 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping shall be any of the following:
 - 1. Hubless, cast-iron soil pipe and fittings; hubless-piping couplings; and coupled joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- A. Aboveground, vent piping shall be any of the following:
 - 1. Hubless, cast-iron soil pipe and fittings; hubless-piping couplings; and coupled joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- B. Underground, soil, waste, and vent piping shall be any of the following:
 - 1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION 221316

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

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. Cleanouts.
 - 2. Floor drains.
 - 3. Through-penetration firestop assemblies.
 - 4. Flashing materials.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FOG: Fats, oils, and greases.

1.4 SUBMITTALS

- A. General:
 - 1. Comply with Section 22 05 03.00 "Submittals for Plumbing."
- B. Product Data (PD):
 - 1. Provide product datasheets for:
 - a. Cleanouts.
 - b. Floor drains.
 - c. Through-penetration firestop assemblies.

1.5 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.6 COORDINATION

- A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Exposed Cleanouts:
 - 1. Cast-iron Exposed Cleanouts:
 - a. Provide product equal to Zurn Z1440 cleanout with Dura-Coated cast iron body with gas and watertight ABS tapered thread plug.
 - b. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Josam Company; Josam Div.
 - 2) MIFAB, Inc.
 - 3) Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - 4) Tyler Pipe; Wade Div.
 - 5) Watts Drainage Products Inc.
 - 6) Zurn Plumbing Products Group; Light Commercial Operation.
 - 7) Zurn Plumbing Products Group; Specification Drainage Operation.
 - 8) Kusel Equipment Co.
 - 9) Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - 10) Josam Company; Blucher-Josam Div.
 - c. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
- A. Floor Cleanouts:
 - 1. Cast-iron Floor Cleanouts:
 - a. Provide product equal to Zurn ZN1400 adjustable floor cleanout, Dura-Coated cast iron body with gas and watertight ABS tapered thread plug and round scoriated secured top adjustable to finish floor.
 - b. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Josam Company; Josam Div.
 - 2) MIFAB, Inc.
 - 3) Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

- 4) Tyler Pipe; Wade Div.
 - 5) Watts Drainage Products Inc.
 - 6) Zurn Plumbing Products Group; Light Commercial Operation.
 - 7) Zurn Plumbing Products Group; Specification Drainage Operation.
 - 8) Kusel Equipment Co.
 - 9) Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - 10) Josam Company; Blucher-Josam Div.
- c. Standard: ASME A112.36.2M for adjustable housing cleanout.

A. Wall Cleanouts:

1. Cast-iron Wall Cleanouts:

- a. Provide cleanout plug complete with product equal to Zurn Z1460-9 square wall access panel and frame. Smooth, nickel bronze panel secured to frame, set flush to finish wall plane, complete with securing lugs
- b. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Josam Company; Josam Div.
 - 2) MIFAB, Inc.
 - 3) Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - 4) Tyler Pipe; Wade Div.
 - 5) Watts Drainage Products Inc.
 - 6) Zurn Plumbing Products Group; Light Commercial Operation.
 - 7) Zurn Plumbing Products Group; Specification Drainage Operation.
 - 8) Kusel Equipment Co.
 - 9) Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - 10) Josam Company; Blucher-Josam Div.
- c. Standard: ASME A112.36.2M. Include wall access.

2.2 FLOOR DRAINS

A. Cast-iron Floor Drains:

1. Refer to schedule on drawings for manufacturer and model number(s).
2. Shower drains shall be Zurn Z-415 with double drainage flange, weep holes, caulked outlet, 6" nickel bronze strainer.
3. All floor drains located in rooms with tile floors shall be provided with manufacturer's standard square grate.
4. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Commercial Enameling Co.
 - b. Josam Company; Josam Div.
 - c. MIFAB, Inc.
 - d. Prier Products, Inc.
 - e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - f. Tyler Pipe; Wade Div.

- g. Watts Drainage Products Inc.
- h. Josam Company; Josam Div.
- i. MIFAB, Inc.
- j. Zurn Plumbing Products Group; Light Commercial Operation.
- k. Zurn Plumbing Products Group; Specification Drainage Operation.
- l. Kusel Equipment Co.

5. Standard: ASME A112.6.3.

B. Refer to schedule on drawings for manufacturer and model number(s).

2.3 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

- 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Acorn Engineering Company; Elmdor/Stoneman Div.
 - b. Thaler Metal Industries Ltd.
 - c. ProSet Systems Inc.
 - d. Josam Company; Josam Div.
 - e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - f. Tyler Pipe; Wade Div.
 - g. Watts Drainage Products Inc.
 - h. Zurn Plumbing Products Group; Light Commercial Operation.
 - i. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch-thick, lead flashing collar and skirt extending at least 6 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

C. Frost-Resistant Vent Caps: Install frost-resistant vent caps on each vent pipe passing through roof, and elsewhere where indicated. Maintain 1" clearance between vent pipe and roof substrate. Coordinate vent penetrations with HVAC equipment. Maintain a minimum of 10 feet clearance from all outside air intakes, relief louvers, exhaust louvers and any other opening to the inside which could receive sewer gas infiltration.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

- 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Acorn Engineering Company; Elmdor/Stoneman Div.
 - b. Thaler Metal Industries Ltd.

c. ProSet Systems Inc.

2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Hub Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

C. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

D. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

E. Stack Flashing Fittings:

1. Description: Counter-flashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.

2. Size: Same as connected stack vent or vent stack.

F. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

G. Frost-Resistant Vent Terminals:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

2.6 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft..
2. Vent Pipe Flashing: 8 oz./sq. ft..

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.

- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

- D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

- E. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

- F. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

- G. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - 2. Size: Same as floor drain inlet.

- H. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- I. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- J. Install vent caps on each vent pipe passing through roof.

3.2 CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
 - 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 076200 "Sheet Metal Flashing and Trim."
- F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

- G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

SECTION 223001 - THERMOSTATIC MIXING VALVES

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. Point-Of-Use Thermostatic Mixing Valves For Public Hand Washing Sinks And Lavatories

1.3 SUBMITTALS

- A. General:

- 1. Comply with Section 22 05 03.00 "Submittals for Plumbing."

- B. Product Data (PD):

- 1. Provide product datasheets for all thermostatic mixing valves. Include rated capacities, operating characteristics, furnished specialties, and accessories.

- C. Closeout Submittals (CO):

- 1. Provide operation and maintenance manuals for all thermostatic mixing valves.

1.4 QUALITY ASSURANCE

- A. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Retain protective covers and protective coatings during storage.

PART 2 - PRODUCTS

2.1 POINT-OF-USE THERMOSTATIC MIXING VALVES FOR PUBLIC HAND WASHING SINKS AND LAVATORIES

- A. Tempered water shall be delivered from public hand-washing facilities (lavatories and sinks) through an approved water-temperature limiting device that conforms to ASSE 1070.
- B. Set outlet temperature of thermostatic mixing valve to 110 degrees F.
- C. Point-of use thermostatic mixing valves shall be equal to Watts Series USG-B. Route tempered water to hot water side of sink/lavatory.
- D. Available Manufacturers: Subject to compliance with requirements, manufacturers offering valves which may be incorporated in the work include, but are not limited to, the following:
 - 1. Symmons
 - 2. Lawler
 - 3. Leonard
 - 4. Powers
 - 5. Bradley
 - 6. Watts

PART 3 - EXECUTION

3.1 THERMOSTATIC MIXING VALVE INSTALLATION

- A. Install equipment and all accessories in accordance with manufacturer's installation instructions.
- B. Piping: Connect hot and cold water piping to unit with shutoff valves.
- C. Start-up, test and adjust equipment in accordance with manufacturer's start-up instructions.

3.2 ADJUSTING

- A. Adjust thermostatic mixing valves to the proper set-point temperature.

END OF SECTION 223001

SECTION 223002 - CIRCULATING PUMPS

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. Circulating pumps for hot water return.

1.3 SUBMITTALS

- A. General:
 - 1. Comply with Section 22 05 03.00 "Submittals for Plumbing."
- B. Product Data (PD):
 - 1. Provide product datasheets for all circulating pumps. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- C. Closeout Submittals (CO):
 - 1. Provide operation and maintenance manuals for all circulating pumps.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Retain protective covers and protective coatings during storage.

PART 2 - PRODUCTS

2.1 CIRCULATING PUMPS FOR HOT WATER RETURN

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering pumps which may be incorporated in the work include the following::
- a. Bell and Gossett
 - b. Armstrong
 - c. Peerless
 - d. Grundfos
 - e. Taco
 - f. Aurora Pump Co.
 - g. Paco.

PART 3 - EXECUTION

3.1 PUMP INSTALLATION

1. Install equipment and all accessories in accordance with manufacturer's installation instructions.
2. Connect piping to pump with unions.
3. Start-up, test and adjust equipment in accordance with manufacturer's start-up instructions.

END OF SECTION 223002

SECTION 223300 - ELECTRIC, DOMESTIC-WATER HEATERS

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. Commercial, electric, storage, domestic-water heaters.
 - 2. Domestic-water heater accessories.

1.3 SUBMITTALS

- A. General:
 - 1. Comply with Section 22 05 03.00 "Submittals for Plumbing."
- B. Product Data (PD):
 - 1. Provide product datasheets for all water heaters. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
 - 3. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1, Section 7, "Service Water Heating."
- C. Closeout Submittals (CO):
 - 1. Provide operation and maintenance manuals for all water heaters.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
- C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.5 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.

PART 2 - PRODUCTS

2.1 COMMERCIAL, ELECTRIC, DOMESTIC WATER HEATERS

- A. Commercial, Electric, Storage, Domestic-Water Heaters:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Water Heaters.
 - b. Bradford White Corporation.
 - c. Cemline Corporation.
 - d. Electric Heater Company (The).
 - e. GSW Water Heating.
 - f. HESco Industries, Inc.
 - g. Heat Transfer Products, Inc.
 - h. Lochinvar Corporation.
 - i. Precision Boilers, Inc.
 - j. PVI Industries, LLC.
 - k. RECO USA.
 - l. Rheem Manufacturing Company.
 - m. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
 - n. State Industries.
 - o. Vaughn Manufacturing Corporation.
 - 2. Standard: UL 1453.

2.2 DOMESTIC WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AMTROL Inc.
 - b. Flexcon Industries.
 - c. Honeywell International Inc.
 - d. Pentair Pump Group (The); Myers.
 - e. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
 - f. State Industries.
 - g. Taco, Inc.
2. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
3. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.

B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.

D. Heat-Trap Fittings: ASHRAE 90.2.

E. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

F. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than domestic-water heater working-pressure rating.

G. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.

H. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base.
1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
 2. Maintain manufacturer's recommended clearances.
 3. Arrange units so controls and devices that require servicing are accessible.
 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 7. Install anchor bolts to elevations required for proper attachment to supported equipment.
 8. Anchor domestic-water heaters to substrate.
- B. Install electric, domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."
- C. Install combination temperature-and-pressure relief valves in water piping for electric, domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."
- E. Install thermometers on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- F. Assemble and install inlet and outlet piping manifold kits for multiple electric, domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each electric, domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each electric, domestic-water heater outlet. Comply with requirements for valves specified in Section 220523 "General-Duty Valves for Plumbing

Piping," and comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

- G. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
- H. Fill electric, domestic-water heaters with water.
- I. Charge domestic-water compression tanks with air, where required.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
- C. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain domestic-water heaters.

END OF SECTION 223300

SECTION 224000 - PLUMBING FIXTURES

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. Water closets.
 - 2. Urinals
 - 3. Flushometer valves.
 - 4. Toilet seats.
 - 5. Lavatories.
 - 6. Stainless steel sinks.
 - 7. Service Receptors.
 - 8. Faucets.
 - 9. Showers
 - 10. Drinking fountains and water coolers.
 - 11. Supply Fittings.
 - 12. Carriers.

1.3 SUBMITTALS

- A. General:
 - 1. Comply with Section 22 05 03.00 "Submittals for Plumbing."
- B. Product Data (PD):
 - 1. Provide product datasheets for all plumbing fixtures.
 - 2. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fixtures.
 - 3. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 4. Include diagrams for power, signal, and control wiring of automatic fixtures where applicable.
 - 5. Fixtures provided shall meet the flow rates of those specified in order to meet the water-use reduction goals desired.
 - 6. Provide product Data for Water Efficiency Prerequisites and Credits as required: Documentation indicating flow and water consumption requirements.

C. Closeout Submittals (CO):

1. Provide operation and maintenance manuals for all plumbing fixtures.
2. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents as indicated below:
 - a. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.
 - b. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed but not less than one.
 - c. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed but not less than one.
 - d. Filter Cartridges for Drinking Fountains and Water Coolers: Equal to 20 percent of quantity installed for each type and size indicated, but no fewer than 1 of each.

PART 2 - PRODUCTS

2.1 WATER CLOSETS

A. Water Closets:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. <http://www.specagent.com/LookUp/?uid=123456810699&mf=04&src=wdAmerican Standard America>.
 - b. Crane Plumbing, LLC.
 - c. Kohler Co.
 - d. Toto USA, Inc.
 - e. Zurn Industries, LLC; Commercial Brass and Fixtures.

2.2 URINALS

A. Wall-Hung and Floor-Set Urinals

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. <http://www.specagent.com/LookUp/?uid=123456810699&mf=04&src=wdAmerican Standard America>.
 - b. Crane Plumbing, LLC.
 - c. Kohler Co.
 - d. Toto USA, Inc.
 - e. Zurn Industries, LLC; Commercial Brass and Fixtures.

2.3 FLUSHOMETER VALVES

A. Flushometer Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. <http://www.specagent.com/LookUp/?uid=123456810699&mf=04&src=wdSloan> Valve Company.
 - b. Zurn Industries, LLC; Commercial Brass and Fixtures.
 - c. Geberit.

2.4 TOILET SEATS

A. Toilet Seats:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Standard America.
 - b. Bemis Manufacturing Company.
 - c. Centoco Manufacturing Corporation.
 - d. Church Seats.
 - e. Jones Stephens Corp.; Comfort Seat Brand.
 - f. Kohler Co.
 - g. Olsonite Seat Co.
 - h. Sanderson Plumbing Products, Inc.
 - i. Sperzel of Lexington.
 - j. Toto USA, Inc.
 - k. Zurn Industries, LLC; Commercial Brass and Fixtures.

2.5 LAVATORIES

A. Lavatories:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. [http://www.specagent.com/LookUp/?uid=123456810699&mf=04&src=wdAmerican Standard America](http://www.specagent.com/LookUp/?uid=123456810699&mf=04&src=wdAmericanStandardAmerica).
 - b. Crane Plumbing, LLC.
 - c. Kohler Co.
 - d. Toto USA, Inc.
 - e. Zurn Industries, LLC; Commercial Brass and Fixtures.

2.6 STAINLESS STEEL SINKS

A. Stainless Steel Sinks:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Elkay Manufacturing Co.
 - b. Just Manufacturing.
 - c. Advance Tabco.
 - d. Eagle Group; Foodservice Equipment Division.
 - e. Amtekco Industries, Inc.
 - f. Acorn Engineering Co.

2.7 SERVICE RECEPTORS

A. Service Receptors:

1. Provide accessible check valves on the hot and cold water supply piping serving all service sinks (including mop sinks).
2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Standard America.
 - b. Crane Plumbing, LLC.
 - c. Acorn Engineering Co.
 - d. Zurn Industries, LLC; Commercial Brass and Fixtures.
 - e. Stern-Williams Co., Inc.
 - f. E.L. Mustee & Sons, Inc.
 - g. Creative Industries, Inc.
 - h. Mustee, Inc.
 - i. Florestone Products Co., Inc.

2.8 FAUCETS

A. Lavatory, Sink, Bathtub, and Shower Faucets:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Standard America.
 - b. Bradley Corporation.
 - c. Chicago Faucet Company.
 - d. Delta Faucet Company.
 - e. Elkay Manufacturing Co.
 - f. Grohe America, Inc.
 - g. Just Manufacturing.
 - h. Kohler Co.
 - i. Speakman Company.
 - j. T & S Brass and Bronze Works, Inc.
 - k. Zurn Industries, LLC; Commercial Brass and Fixtures.
 - l. Geberit.

- m. Symmons Industries, Inc.
- n. Powers, Watts Water Technologies Co.
- o. <http://www.specagent.com/LookUp/?uid=123456810699&mf=04&src=wdSloan>
Valve Company.
- p. Encore by CHG.

2.9 SHOWERS

A. Showers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. <http://www.specagent.com/LookUp/?uid=123456810699&mf=04&src=wdAcorn>
Engineering Company.
 - b. Acryline USA, Inc.
 - c. Aqua Bath Company, Inc.
 - d. Aquatic Industries, Inc.
 - e. American Standard America.
 - f. Aqua Glass Corporation.
 - g. Bradley Corporation.
 - h. Clarion Bathware.
 - i. Crane Plumbing, LLC.
 - j. Florestone Products Co., Inc.
 - k. Jacuzzi, Inc.
 - l. Jason International, Inc.
 - m. Kohler Co.
 - n. LASCO Bathware.
 - o. MAAX.
 - p. MAAX; Aker Division.
 - q. Mustee, E. L. & Sons, Inc.
 - r. Praxis Industries, LLC; Aquarius Bathware.
 - s. Royal Baths Manufacturing Co.
 - t. Swan Corporation (The).
 - u. Sterling; a Kohler company.
 - v. Stern-Williams Co., Inc.
 - w. Toto USA, Inc.
 - x. Tower Industries.
 - y. Willoughby Industries, Inc.
 - z. Zurn Industries, LLC; Commercial Brass and Fixtures.

2.10 DRINKING FOUNTAINS AND WATER COOLERS

A. Drinking Fountains and Water Coolers:

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

- a. Elkay Manufacturing Co.
- b. Kohler Co.
- c. Belson Outdoors, Inc.
- d. Haws Corporation.
- e. Petersen Manufacturing Co., Inc.
- f. Sanderson Concrete Inc.
- g. Stern-Williams Co., Inc.
- h. Halsey Taylor.
- i. Most Dependable Fountains, Inc.
- j. Murdock-Super Secur; a division of Acorn Engineering Company.
- k. Tri Palm International, LLC; Oasis Brand.
- l. Filtrine Manufacturing Company.
- m. Larco Inc.

2.11 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.
- D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Risers:
 1. NPS 1/2.
 2. Chrome-plated, rigid-copper-pipe and brass straight or offset tailpieces, chrome-plated, soft-copper flexible tube, ASME A112.18.6, braided- or corrugated-stainless-steel, flexible hose riser.

2.12 FIXTURE CARRIERS

- A. Fixture Carriers:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. <http://www.specagent.com/LookUp/?uid=123456810699&mf=04&src=wdJosam> manufacturing Company.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.

- e. Watts Drainage Products Inc.
- f. Zurn Plumbing Products Group; Specification Drainage Operation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls and floors for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General Fixture Installation:

- 1. Install fixtures level and plumb according to roughing-in drawings.

B. Wall Flange and Escutcheon Installation:

- 1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
- 2. Install deep-pattern escutcheons if required to conceal protruding fittings.
- 3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

C. Joint Sealing:

- 1. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
- 2. Match sealant color to water-closet color.
- 3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

D. Traps:

- 1. Install traps on fixture outlets.
 - a. Exception: Omit trap on fixtures with integral traps.
 - b. Exception: Omit trap on indirect wastes unless otherwise indicated.

E. Water Closet Installation:

- 1. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.

2. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.
3. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
4. Use carrier supports with waste-fitting assembly and seal.
5. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.
6. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.
7. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

F. Urinal Installation:

1. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
2. Install wall-hung, bottom-outlet urinals with tubular waste piping attached to supports.
3. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1.
4. Install trap-seal liquid in waterless urinals.
5. Install supports, affixed to building substrate, for wall-hung urinals.
6. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
7. Use carriers without waste fitting for urinals with tubular waste piping.
8. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.

G. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each flushometer fixture.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible fixtures with handle mounted on open side of fixture.
4. Install actuators in locations that are easy for people with disabilities to reach.
5. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

H. Toilet Seat Installation:

1. Install toilet seats on water closets.

I. Lavatory and Sink Installation:

1. Install level and plumb according to roughing-in drawings.
2. Install supports, affixed to building substrate, for wall-mounted lavatories.
3. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.
4. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."
5. Install counter-mounting fixtures in and attached to casework.
6. Install pedestal lavatories on pedestals and secured to wood blocking in wall.

J. Faucet Installation:

1. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
2. Install shower flow-control fittings with specified maximum flow rates in shower arms.

K. Shower Installation:

1. Assemble shower components according to manufacturers' written instructions.
2. Install showers level and plumb according to roughing-in drawings.
3. Install water-supply piping with stop on each supply to each shower faucet.
 - a. Exception: Use ball, gate, or globe valves if supply stops are not specified with shower. Comply with valve requirements specified in Section 220523 "General-Duty Valves for Plumbing Piping."
 - b. Install stops in locations where they can be easily reached for operation.
4. Install shower flow-control fittings with specified maximum flow rates in shower arms.
5. Set shower receptors and shower basins in leveling bed of cement grout.

L. Drinking Fountain and Water Cooler Installation:

1. Set free-standing drinking fountains and water coolers on floor.
2. Install recessed drinking fountains secured to wood blocking in wall construction.
3. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
4. Install frost-resistant drinking fountains in a manner that prevents supply and drain piping from freezing. Chases containing supply and drain piping for frost-resistant drinking fountains shall be open to the heated space and insulation shall be provided on the cold side.
5. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, risers, traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to fixtures, allow space for service and maintenance.

- E. Install protective-shielding pipe covers and enclosures on exposed supplies and waste piping of accessible fixtures. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.4 ADJUSTING

- A. Operate and adjust fixtures and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Adjust water pressure at fixtures to produce proper flow.
- C. Where applicable, install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

- A. Clean fixtures and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed fixtures and fittings.
- C. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224000

SECTION 230170 - OPERATION AND MAINTENANCE OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Operation and Maintenance Manuals.
 - 2. Instructions for Owner's Personnel.

1.3 ALLOWANCES

1.4 DEFINITIONS

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Detail fabrication and assembly.
 - 4. Include diagrams for power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

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

- B. Qualification Data: For manufacturer.
- C. Welding certificates.
- D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For equipment and systems to include in operation and maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code – Steel."
- C. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.9 DELIVERY, STORAGE, AND HANDLING

1.10 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components that fail(s) in materials or workmanship within specified warranty period.
 - 1. Warranty Period: five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OPERATING AND MAINTENANCE MANUALS

- A. (2) hard copies of the O&M must be submitted to the owner.
- B. The contents of operating and maintenance manuals shall include the following:
 - 1. Description of mechanical equipment and systems.
 - 2. Operating instructions.
 - 3. Routine maintenance schedules and procedures.

- C. Organization - A manual of such purpose shall be arranged in two parts, with Part I dealing with information pertaining to systems and Part II covering information pertaining to equipment. These may be bound in as many volumes as may be required for convenience of use and reference.
1. Part 1 - Systems:
 - a. The systems volumes shall be organized into Divisions wherein each Division represents a generic function. Systems shall be classified under appropriate Divisions. An example of such an arrangement is as follows:
 - b. Division Title Division No.
 - 1) Cooling 1.0
 - a) Air Conditioning
 - 2) Heating 2.0
 - 3) Ventilating
 - a) Building Exhaust
 - b) Toilet Exhaust
 - c. The material for each system shall be organized in sections descriptive of the following basic areas of information:
 - 1) Descriptive Information.
 - 2) Operating Instructions.
 - 3) Inspection and Maintenance Instructions.
 - d. Sections could be organized to include the following categories of information:
 - 1) Descriptive Information
 - 2) Function of service.
 - 3) Classification.
 - 4) Design capability.
 - 5) Performance characteristics.
 - 6) Principal components.
 - 7) Distribution arrangement.
 - 8) Schematic diagram.
 - 9) Control diagram.
 - 10) Equipment Data.
 - 11) Inventory designation.
 - 12) Manufacturer and model.
 - 13) Size and rating.
 - 14) Pressure, speed and temperature limitations.
 - 15) Operating Instructions.
 - 16) Starting and stopping procedures.
 - 17) Adjustment and regulation.
 - 18) Seasonal start-up.
 - 19) Seasonal shut-down.
 - 20) Logs and records.
 - 21) Inspection and Maintenance.
 - 22) Inspection schedule and checklist.
 - 23) Schedules and procedures for lubrication, replacements, adjustment, cleaning, painting, protection and testing.
 - 24) Inspection and maintenance records.
 - e. Reference Documents:
 - 1) Construction drawing list.
 - 2) Construction specifications.

- 3) Record drawings.
 - 4) Test and balance records.
2. Part 2 - Equipment:
- a. This part of the manual shall be composed of manufacturers and fabricators data on equipment and materials organized into divisions wherein each division represents a generic classification of equipment such as:
 - b. Division Title
 - 1) Air Conditioning and Ventilating
 - 2) Controls
 - 3) Instrument and Accessories
 - 4) Motors
 - c. Each division shall be organized in sections wherein each section would represent a specific type of equipment in Division 1, the sections shall include the following:
 - 1) Air Conditioning and Ventilating
 - a) Coils - Cooling
 - d. Each section shall include the following manufacturer information:
 - 1) Descriptive Literature
 - a) Catalog cuts, brochures or shop drawings
 - b) Dimensional drawings
 - c) Materials of construction
 - d) Parts designations
 - 2) Operating Characteristics
 - a) Performance tables and charts
 - b) Performance curves
 - c) Pressure, temperature and speed limitations
 - d) Safety devices
 - 3) Operating Instructions
 - a) Pre-start check list
 - b) Start-up procedures
 - c) Inspection during operation
 - d) Adjustment and regulation
 - e) Testing
 - f) Detection of malfunction
 - g) Precautions
 - 4) Inspection Instruments and Procedures
 - a) Normal and abnormal operating temperature, pressure and speed limits
 - b) Schedule and manner of operation
 - c) Detection signals
 - 5) Maintenance Instructions and Procedures
 - a) Schedule of routing maintenance
 - b) Procedures
 - c) Troubleshooting chart
 - 6) Parts List
 - a) Spare Parts
 - b) Essential inventory
 - c) Distributor directory
 - 7) Service and Dealer Directory
 - 8) Service Contracts

PART 3 - EXECUTION

3.1 INSTRUCTIONS FOR THE OWNER'S PERSONNEL

- A. Arrange for suppliers and/or installers to meet with the Owner's operating and maintenance personnel to provide instruction in the proper operation and maintenance of equipment that requires routine servicing. Include the following:
1. Review of operation and maintenance manuals.
 2. Required tools.
 3. Lubricants.
 4. Spare parts.
 5. Cleaning.
 6. Hazards.
 7. Warranties and maintenance agreements.
- B. Demonstrate equipment and systems operation including the following:
1. Start-up.
 2. Shut-down.
 3. Emergency conditions.
 4. Safety procedures.
 5. Setpoint and schedule adjustments.
 6. Economy and efficiency adjustments.

END OF SECTION 230170

SECTION 230501 - COMMON REQUIREMENTS FOR HVAC

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 all sections.

1.2 SUMMARY

- A. Scope:

1. The base bid shall include furnishing all materials, labor, tools, equipment and installation of all work required to install complete mechanical systems as outlined in the contract documents.
2. Submittal of a bid indicates that the contractor has examined the drawings, specifications, and visited the site and has included all required allowances for a complete bid.
3. Contractor shall be designated as the sub-contractor for that section of work unless specifically stated otherwise.

- B. Permits, Fees, Inspection, Laws and Regulations

1. Permits and fees of every nature required in connection with this work shall be obtained and paid for by this contractor who shall also pay for all the installation fees and similar charges.
2. Laws and regulations which bear upon or affect the various branches of this work shall be complied with by this contractor, and are hereby made a part of this contract.
3. All work which laws require to be inspected shall be submitted to the proper public officials for inspections and certificates of final approval must be furnished to the Owner before final acceptance will be given by the Engineer.

1.3 ELECTRONIC FILES

- A. Drawings for this project were prepared using AutoCAD software. Electronic files are available upon request for use by the successful contractor(s) for planning, coordination and installation.
- B. There will be no charge for drawing files that were prepared using AutoCAD. These files will be available in the version in which they were created.
- C. The Request Drawings Form can be accessed, filled out and submitted at the following internet address at the bottom of the page: <http://www.klhengrs.com>.

1.4 QUALITY ASSURANCE

A. General Standards

1. The installation of all work shall conform to the applicable State and Local codes and statutes. The applicable provisions of the following standards shall govern:
 - a. State Building Code and applicable local amendments.
 - b. Local Building Code (if applicable)
 - c. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).
 - d. American Society of Test Materials (ASTM)
 - e. National Fire Protection Association (NFPA)
 - f. Underwriters Laboratories (UL)
 - g. National Sanitation Foundation (NSF)
 - h. Sheet Metal & Air Conditioning Contractors National Association (SMACNA)
 - i. American National Standards Institute (ANSI)
 - j. Building Code Seismic Relative Displacement Requirements

B. Definitions and Descriptions

1. "AS SHOWN" – As shown, indicated or described on the contract documents.
2. "CONTRACT DOCUMENTS" – Drawings, specification sections, contracts and submittals.
3. "CONTRACTOR DOCUMENTS" – All documents submitted by the contractor.
4. "PROVIDE" – To furnish and install.
5. "WORK" – All labor, materials and equipment described by the contract documents.
6. "WORK OF OTHER TRADES" – Work included in this contract that is normally described in other Sections of the Specifications under the Construction Specification Institute's 28 Division format.
7. "REMOVE" – To disconnect, dismantle or disconnect and dismantle as necessary. All removals not designated for reuse nor designated to be salvaged for the Owner is the property of the contractor unless stated otherwise.
8. "REPLACE" – To remove existing and provide new as indicated in the same location.
9. "COORDINATE" – To locate and avoid both new and existing equipment, services and obstructions.
10. "REROUTE" – To remove part of system and provide extension to system to circumvent obstruction.
11. "RELOCATE" – To remove existing, install existing in a different location and make operational.
12. "REINSTALL" – To remove existing, install existing in the same location and make operational.

C. Qualifications

1. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

D. Supervision and Workmanship

1. Workmanship throughout shall conform to the standards of best practice and all labor employed must be competent and qualified to do all the work required.
2. Contractor shall furnish the services of an experienced superintendent to be in constant charge of the work at all times.
3. Quality Assurances: Contractor if requested shall demonstrate his ability to perform all work to be included under the contract. Assurance if requested, shall be in the form of a list of past projects of similar size and complexity and a list of six (6) references pertaining to those projects. Failure to demonstrate these quality assurances shall be taken as a statement of the contractor's inability to perform.
4. Contractor shall have a minimum five (5) years experience in the installation of HVAC systems similar to the systems specified.
5. Core Drilling: Contractors shall use core drills rather than percussion type equipment for making holes in concrete. All percussion type drilling including hammer drills must be scheduled through owner's representative. Openings shall be no larger than required to install services.
6. Inspection: Provisions shall be made for owner's representative to make rough-in and open ceiling inspections prior to covering up work.

E. Materials

1. All materials installed shall be new, full weight and of the best quality. All similar materials shall be of the same type and manufacturer.
2. Contractor is responsible for the safety and good condition of the materials and equipment installed until final acceptance by the Owner. Materials shall be stored to prevent damage, freezing or weathering prior to installation.
3. When several materials, products or items of equipment are specified by name for one use, the contractor may select any one of those specified and shall include with his bid and Equipment List listing the equipment selected.
4. Any manufacturer(s) other than scheduled shall have unit dimensions, weights and clearances equal to or less than any specified base-bid equipment, unless reviewed by the Engineer.
5. The responsibility for costs incurred from deviation from the base scheduled and specified equipment shall be this contractor. Use of any equipment will be considered as a statement that capacities, requirements, clearances and arrangements have been checked, verified and found satisfactory and meet the intent of the scheduled and specified equipment. Such additional costs shall not be approved for these modifications.
6. Should electrical characteristics for submitted HVAC equipment differ from the scheduled basis of design equipment electrical characteristics, any costs associated with the different electrical characteristics shall be borne by this Division's contractor without additional compensation.
7. All manufacturer or Mechanical Contractor provided electrical disconnect switches shall comply with current National Electric Code requirements and rated to meet or exceed the overcurrent device serving the equipment.

F. Specifications

1. Specifications shall be interpreted in connection with the drawings hereinbefore described, and if anything is shown on drawings and not mentioned in the specifications, or vice versa, it is to be included in the work the same as though clearly set forth by both.

2. Furthermore, all materials or labor previously required to fully complete the work shall be included in the contractor's work even though each item necessarily involved be not specifically mentioned or shown. Such work and/or materials shall be of the same grade or quality as the parts actually specified and shown. Should there be a conflict between the plans and specifications, the greater quantity or better quality shall be furnished.

G. Plans

1. Plans are diagrammatic indicating required size, points of termination of ducts and pipes and suggested routes. However, it is not intended that drawings indicate all necessary offsets. It shall be the work of the contractor to install piping and ductwork in such manner as to conform to the structure, avoid obstructions, provide required service clearances and preserve headroom. Take field measurements to make these determinations. Do not rely on measurements taken or provided by others or scaled from drawings.
2. Coordination Drawings: The contractor shall provide a 1/4" scale double line set of coordination drawings to the Engineer prior to installation of the systems. This contractor shall provide all necessary coordination drawings required to make sure all disciplines are coordinated and fit into specified mechanical spaces (i.e. ceilings, chases, and all others). The top elevation of all disciplines shall be clearly marked throughout the drawings so that no interferences occur. Drawings shall depict actual clearances of installed equipment, penetration locations and service clearances. Indicate scheduling, sequencing, movement and positioning of large equipment during construction. Indicate where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the work. Conflicts in equipment and materials shall be corrected prior to installation. Contractor shall provide drawings showing all disciplines for coordination.
3. Exact location of electric outlets, heating equipment, piping, lighting fixtures, ducts, etc., shall be coordinated so there will be no interferences at installation between the various trades. It is the work of the contractor to prepare complete coordination drawings indicating exact location of all items. The engineer shall have the option to move any piece of mechanical equipment up to fifteen feet from location shown on contract documents without any additional cost.
4. All ducts and piping shall be run as straight as possible and symmetrical with architectural items.
5. Piping shall be concealed in pipe shafts, pipe spaces, and furring wherever possible.
6. Ductwork and piping fabricated before coordination with the other trades will be done at the contractor's risk.

H. Utility Verification Requirements

1. Field verify locations of underground and aboveground utilities, or those otherwise obscured from view, in the vicinity of work prior to commencing work.
2. Camera/Scope existing piping, ductwork and pathways to confirm existing conditions and use including, but not limited to, voltage, natural gas pressure, sanitary, storm, chilled water, steam, etc...)
3. Obtain on-site approval from local utility prior to connected to existing services.
4. Failure to perform the above shall result in contractor proceeding at their risk and accepting full responsibility for incorrect connections.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment and materials according to factory shipping requirements. Pack components in factory-fabricated protective containers. Units shall be delivered in sections of such size as will pass through available openings.
- B. Store equipment and materials in clean dry place and protect from weather and construction traffic. When stored inside, do not exceed structural capacity of the floor.
- C. Handling and rigging of equipment and products shall be as recommended by the manufacturer. Components and equipment damaged during shipment or handling shall not be installed. Replace and return damaged components to the manufacturer.
- D. All equipment and materials shall have the ability to be returned to the manufacturer after purchase and charged a reasonable restocking fee by the manufacturer equal to a small portion of the cost.

1.6 WARRANTY

- A. The contractor shall provide a guarantee in written form stating that all work under this section shall be free of defective work, materials, or parts for a period of one year from the date of substantial completion owner's final acceptance and shall repair, revise or replace at no cost to the owner any such defects occurring within the guarantee period. Contractor shall also state in written form that any items or occurrences arising during the guarantee period will be attended to in a timely manner and will in no case exceed four (4) working days from date of notification by owner.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine products or materials before installation. Reject products or materials that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for piping to verify actual locations of piping connections before equipment installation.
- D. Examine walls, floors, roofs, etc. for suitable conditions where product or system will be installed.

- E. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY SERVICE

- A. Refer to Division 01
- B. Temporary Heating or Cooling: Provide, maintain and pay for all charges for temporary heating or cooling and adequate ventilation in all construction areas of the project, as may be deemed necessary to protect the building and work installed therein from damage due to cold, dampness, or humidity and shall maintain heating or cooling during finishing operations and until date of final completion. Use of permanent and existing building heating/cooling systems will not be permitted without prior written permission from the owner, architect, and engineer.

3.3 FIRE ALARM RELATED WORK FOR MECHANICAL SYSTEMS

- A. The following applies whether or not shown on drawings. Prior to submitting a bid, each contractor shall review documents of all other branches which may have an impact on such work.
 - 1. It shall be the responsibility of the contractor who installs the alarm panel and/or wiring to provide all necessary working drawings and submittals (wiring diagrams, zone schedule, plan view layouts, routing, wiring, device & panel submittals, etc.). These submittals shall be reviewed by the State Fire Marshall's office (or a similar agency as locally required) prior to submittal to engineer. All components shall be UL listed and NFPA approved for their specific application. Where control panels are required, provide remote annunciator (at location as directed in field) and provide full battery back-up as required by NFPA.
 - 2. All smoke detectors shall be specifically UL listed for use with the existing or new building fire alarm panel(s) and shall be provided with all required power supply/alarm wiring, sampling tubes, test station, auxiliary contacts, etc.
 - 3. All work shall be in strict compliance with all applicable sections of the latest edition of NFPA. Each air handling unit, sprinkler flow switch and/or sprinkler tamper switch shall be separately zoned. All fire alarm system wiring shall be supervised and installed in conduit (3/4" minimum).
- B. Unless local prevailing codes require otherwise, fire alarm related work for mechanical systems shall be as follows:
 - 1. If a sprinkler system exists in the building, the sprinkler contractor shall furnish and install all required flow and tamper switches. The Electrical Contractor shall furnish, install and wire all required fire alarm system wiring as well as all required additional components within the fire alarm system control and annunciator panels to allow for the additional zoning.
 - 2. Electrical contractor shall coordinate with mechanical contractors and shall install the detectors in easily accessible locations. Electrical Contractor shall provide all necessary

fire alarm system wiring (in conduit) and supplementary work, components, equipment, etc. as required to interface the sprinkler and/or smoke detector work with the building fire alarm system(s).

3. HVAC Contractor shall make wiring connection from the auxiliary contacts of the relay module or detectors into fan control circuits to shutdown equipment, in a controlled and safe manner, in the presence of smoke. If alarm status for the smoke detector is indicated in specification section 23 09 93.00, then the HVAC/ Temperature Controls Contractor is responsible for providing a control relay and all wiring from the smoke detector to allow notification at the BAS. If a supply & return/exhaust fan arrangement is installed, the HVAC/ Temperature Controls Contractor shall provide a 3-Pole Double Throw relay to shut down both the supply and return/exhaust fans in event of presence of smoke.

3.4 ARCHITECTURAL COORDINATION ITEMS

A. Cutting and Patching:

1. Cut and drill all openings in walls and floors required for the installation. Secure approval of Engineer before cutting and drilling. Neatly patch all openings cut.
2. Cutting and patching to be held to a minimum by arranging with other contractors for all sleeves and openings before construction is started.

B. Fire Caulking:

1. Patching through fire rated walls and enclosures shall not diminish the rating of that wall or enclosure. Patch shall be equal to rockwool, firestop, caulk or approved "rated" patch.
2. Provide products equivalent to the following:
 - a. For Floor Openings: Instant Firestop; 305-SL
 - b. For Wall Openings: Instant Firestop; 344-GG
 - c. Mineral Felt: Instant Firestop; Type MW
 - d. For Insulated Pipes: Instant Firestop; Type PI
 - e. For Fill Areas: Instant Firestop; C-1000
3. For larger openings where pipes penetrate fire rated enclosures that cannot be sealed with products described above, utilize approved UL products equal to 3M FireDam Spray 200. Install per manufacturer's instructions.

C. Access Panels and Pathways:

1. Furnish all access panels required for proper servicing of equipment. Provide access panels for all concealed valves, vents, controls, cleanout doors, and sprinkler devices required by NFPA. Provide access panels for all fire and/or fire & smoke dampers. Provide frame as required for finish. Furnish panels to General Contractor. Exact locations to be approved by the Architect. Minimum size to be 12" x 12", units to be 16 gauge steel, locking device shall be screwdriver cam locks.
2. For equipment above gypsum board or "hard ceilings", provide equipment access panels sized to permit complete holistic removal of the unit in its entirety. Access panel shall also be sized to accommodate removal of the largest piece of equipment in the case where such access panel is used as a removal pathway for multiple pieces of equipment.

3. Provide and maintain a minimum 34" wide by 80" high pathway for removal of equipment. Pathway shall be continuous from location of installed to building exterior. Ductwork, piping and conduit shall not be installed within this pathway.

D. Piping Sleeves:

1. Install standard Schedule 40 black steel pipe sleeves two sizes larger than pipes passing through floors, walls or masonry construction.
2. Sleeves through walls to be cut flush with both faces.
3. Caulk between sleeves and pipes with rockwool and caulk around sleeves with sealing compound. Material must meet all applicable fire ratings required.

E. Piping Escutcheon plates:

1. Install manufactured chromium plated escutcheon plates wherever uninsulated exposed pipes pass through walls, floors, or ceilings. Escutcheon inside diameter to closely fit around pipe and outside diameter to completely cover opening.

F. Piping Penetrations:

1. Furnish and set all forms required in masonry walls or foundation to accommodate pipes.
2. Provide flexible connectors where all pipes or ducts cross building expansion joints equal to Flexonics. Coordinate exact quantity & location with Architectural plans prior to installation of piping or ductwork.

3.5 ROOFING, FINISHED FLOORS AND SLABS

- A. Protect roofs and flooring by using plywood planking to cover walkways and work areas on roofs, slabs and floors.
- B. Make roof penetrations and install insulated roof curbs and flashing in accordance with roofing manufacturer's recommendations. Obtain written certification from roofing manufacturer that work has been performed properly and that roof warranty has not been voided.

3.6 INSTALLATION

- A. Equipment shall be installed in accordance with manufactures installation recommendations.
- B. Provide and maintain service, maintenance and operating clearances as required by the manufacturer.

3.7 CLEANING EQUIPMENT AND PREMISES

- A. Clean all parts of the apparatus and equipment. Exposed parts which are to be painted shall be cleaned of cement, plaster and other materials and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all corners and cracks scraped out.
- B. Exposed metal work shall be brushed down with steel brushes to remove rust and other spots and left smooth and clean. Remove trapped elements during cleaning and flushing period, after which they shall be replaced and adjusted.
- C. During the progress of the work, the contractor shall clean up after his men and leave the premises and all portions of the building in which he is working in a clean and safe condition.

3.8 FIELD QUALITY CONTROL

- A. Prepare test and inspection reports.
- B. Prepare and provide Utility Verification reports.

3.9 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Unit may be started up and utilized only after the floor has been prepared and after drywall sanding has occurred 100%. Coordinate with all trades prior to startup.

3.10 ADJUSTING

- A. Adjust hardware and moving parts to function smoothly, and lubricate as recommended by manufacturer.

3.11 PROTECTION

- A. Protect installed equipment, ductwork, piping, devices and accessories during construction. Items damaged during construction will not be accepted and shall be replaced by this contractor with new at this contractor's expense.
- B. Remove and replace products or materials that are wet, moisture damaged, or mold damaged.

3.12 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 230501

SECTION 230503 - SUBMITTALS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections and Division 23 General Requirements Section apply to this Section.

1.2 SUMMARY

- A. Section Includes: Administrative, content and format requirements for preparation and submission of submittals.
- B. Work of this Section is supplemental and additive to the requirements of Section 013300 where included in the Project Manual.

1.3 PRICE AND PAYMENT PROCEDURES

- A. Payment in full or in part may be withheld from the Contractor for failure to comply with submittal requirements articulated in the Contract Documents.

1.4 SUBMITTALS

- A. Submittals shall be furnished for each Section that includes one or more of the following elements of work:
 - 1. Supply of one or more products.
 - 2. Installation of one or more products.
 - 3. Integration of one or more products.
 - 4. Programming of one or more products.
 - 5. Creation of one or more deliverable products.
 - 6. Labeling of one or more products.
 - 7. Contractor-based design or engineering of one or more products or systems.

1.5 REFERENCES

- A. Definitions:
 - 1. Component Identifier / Component ID: See Device ID.
 - 2. Device.ID: The unique identifier given to a specific instance of a product, module and assembly. Identifiers are unique within the context of the system and product in which it is used.
 - 3. Product Identifier / Product ID: See Device ID.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Submittals shall be routed through established Project channels as identified by the Owner's representative.
- B. Coordinate, assemble, title, transmit and track Project submittals.
- C. Label each submittal of each type similarly for consistency and so they appear as if prepared by the same entity. Like-type submittals (e.g., Product Data) from different Sections shall have the same appearance and organization as those of other Sections.
- D. Submittals prepared by subcontractors or vendors shall not be accepted unless prepared in compliance with the Contract Documents.
- E. Submittal items listed in this Section represent the common items required to be supplied for the various specification Sections throughout the duration of the Project. Individual Sections will vary and may include additional or lesser requirements.
- F. Engineer reserves the right to require additional submittals or to waive select submittal requirements on a Section-by-Section basis.
- G. The cost for preparation and transportation of submittals is Work of the Contract.
- H. Bind physical/hardcopy submittals together. Do not submit loose or paper clipped documents.
- I. Supply separate submittals for each Section. Do not combine multiple Sections together into a single submittal, except where expressly directed within the Contract Documents.
- J. Where electronic submittals are required or permitted, comply with the requirements for electronic submittals as identified in the Contract Documents.
- K. Organize submittals as identified in the Contract Documents.
- L. Furnish submittals for different Sections each with its own transmittal form. A single transmittal shall not be used to identify submittals for more than one (1) Section at a time. This allows for tracking and processing efficiency, so that:
 - 1. Each Section may be reviewed simultaneously by different individuals, as appropriate.
 - 2. Individual Sections may be processed and returned more quickly than others when some Sections require longer review times.

3. Submittals that are returned and marked as “Revise and Resubmit” do not cause submittals for other Sections to be also be resubmitted due to the fact that they were bound together as a single unit.

M. Use of Electronic Drawings from the Owner’s Design Team:

1. Plan drawings for the Project were created with AutoCAD.
2. If expressly permitted by the Owner and the terms of the Contract, editable electronic versions of standard-scale, AutoCAD-based plan drawings may be made available for the creation of shop and as-built drawings.
3. Due to the proprietary nature of internal design systems, editable native-software versions of some drawings, including but not limited to system diagrams and details will not be made available in an editable form. In these cases, electronic versions of the drawings may be made available only in PDF, JPG or similar non-editable electronic form, at the sole discretion of the Designer.

3.2 SUBMITTAL TYPES

A. The following are the common submittal types referenced in this Section:

1. Quality Assurance (QA).
2. Quality Control (QC).
3. Product Data (PD).
4. Shop Drawing (SD).
5. Samples (SS).
6. Training (TG).
7. Field Observation Response (FO).
8. Pre-Acceptances (PA).
9. Closeout Submittal (CO).

3.3 SEQUENCE

A. Quality Assurance Submittal:

1. When not expressly requested to be supplied with bid, the Quality Assurance submittal(s) shall be supplied upon request. When requested the submittal shall be delivered to the Designer within 16 business hours.

B. Product Data Submittal:

1. Submit following contract award or notice of intent to award a contract. Product data shall be submitted and reviewed prior to procurement of materials.

C. Shop Drawing Submittal:

1. Submit for review prior to commencement of fabrication and installation.
2. Submit concurrently with Section-specific Product Data submittals.

D. Training Submittal:

1. Submit thirty (30) days prior to the first training session.

E. Field Observation Report Submittal:

1. Submit five (5) business days prior to punch list walkthrough.

3.4 IDENTIFICATION

A. Identify each submittal uniquely.

B. Identify each submittal by specification Section number, submittal type, and submittal iteration.

C. The format for labeling the submittals shall be as follows:

1. Section Number–Submittal Type Abbreviation–Submittal Iteration.
2. Examples:
 - a. First Product Data Submittal for section 23 31 13.00: “233113-PD-00.”
 - b. Revised Product Data Submittal for section 23 31 13: “233113-PD-01.”
 - c. Second Revised Product Data Submittal for 23 31 13: “233113-PD-02.”

3.5 CONTENTS

A. General:

1. Transmittal:
 - a. Supply a dedicated transmittal for submittals for each individual Section.
 - b. Itemize the specific submittals included by Section, submittal type, and iteration.
2. Title Sheet:
 - a. Include a separate title sheet with each submittal, of each type.
 - b. Title sheets for each Section, for each submittal type, shall have the same appearance.
 - c. Title sheets for product data submittals shall be 8-1/2 inches x 11 inches.
 - d. Title sheets for drawings shall be the same size as the associated drawings.
 - e. Create title sheets to have the appearance and information identified on the sample title sheet published at the end of this Section.
3. Index:
 - a. Include an index outlining and identifying the contents of the submittal.
 - b. The index for drawing submittals shall be incorporated onto the title sheet of the corresponding drawing set.
4. Checklists:

- a. Include the checklist(s) published in the Contract Documents corresponding to the type of submittal being supplied. Applicable checklists are found at the end of this Section and within individual Sections.
5. Title Blocks:
 - a. Drawing submittals shall be created on the Contractor's, manufacturers, or vendor's own title block. The title blocks of the Owner, Architect, Engineer, Designer or their Consultants shall not be reproduced on any document (electronic or hardcopy) that is prepared or altered by the Contractor.
 6. Legend:
 - a. Drawing submittals shall include a legend of symbology.
 7. Resubmittals:
 - a. Resubmittals shall include a replica of the reviewer's comments that necessitated the resubmittal, along with an accompanying item-by-item explanation of the actions taken and changes that will be found within the resubmittal.
- B. Quality Assurance:
1. List of Subcontractors to be used on the Project along with a description of the role each shall play on the Project.
 2. Proof of Quality Assurance compliance, as identified within each Division 23 Section "Quality Assurance" and in each individual Section.
 3. The last six (6) projects that the Contractor (and each proposed Subcontractor) has completed that are of similar scope, size and contract value. References shall include:
 - a. Owner's name and current contact information.
 - b. Project address.
 - c. Description of the system(s) and scope of actual work performed.
 - d. Monetary contract value of the Work performed.
 4. Financial Disclosure of the Contractor: Prior to contract award, upon request.
- C. Product Data Submittals:
1. Product Datasheets:
 - a. Separate manufacturer datasheets for each product.
 - b. Datasheets shall be manufacturer originals or first generation printed versions (i.e., from PDF) of the manufacturer's official electronic datasheet:
 - 1) Distributor modified, distributor branded, and/or html based "web" datasheets are not acceptable.
 - 2) Datasheets shall include size and technical support data.
 - c. Where manufacturer's datasheets depict multiple products, versions and options, indicate via highlighting, underlining, or with bold visible arrows the model(s), version(s) and option(s) being supplied. Exact catalog number(s) shall be indicated.
 - d. Each datasheet shall be labeled with the Section paragraph reference number. Datasheets shall include the Drawing reference when no specific paragraph reference exists within the Section.

D. Shop Drawings Submittals:

1. General:
 - a. Drawing descriptions identify the required contents of common drawings required under the Contract.
 - b. Drawings identified within individual Sections, along with any additional drawings deemed necessary by the Designer, are required.
 - c. Drawing Scales:
 - 1) Floor plans shall be drawn to scale.
 - 2) Section drawings shall be drawn to scale.
 - 3) Elevation drawings shall be drawn to scale.
 - 4) Details of physical items shall be drawn to scale.
 - 5) System drawings and schematic drawings shall be drawn 1:1 (no scale).
 - d. Sizes:
 - 1) Sheet sizes shall match the size of the Contract Drawings sheets, except where otherwise expressly requested or approved in advance by the Designer.
2. Floor Plans:
 - a. Location of major system components.
 - b. Location of equipment that is Work of another Section to which Work interconnects.
3. Reflected Ceiling Plans:
 - a. Location of ceiling devices, coordinated with devices that are Work of others, and existing devices (where applicable).
4. System Diagrams:
 - a. Hybrid schematic / block wiring diagram.
 - b. System products depicted.
 - c. Product inputs, outputs and other ports depicted.
 - d. Product brand, model, description, options, and accessories declared.
 - e. Equipment ID assignment for each product.
 - f. Interconnections depicted between system products.
 - g. Interconnections depicted between system products and related system products.
5. Custom Assemblies and Products:
 - a. Manufacturer.
 - b. Materials.
 - c. Finish and color(s).
 - d. Parts list.
 - e. Nomenclature sizes, colors.
 - f. Dimensions.
 - g. Schematic diagram(s), where applicable.
6. Mounting Details:
 - a. Depicting the materials and means of securing installed products.
 - b. Finishes and colors of exposed parts.

E. Training Submittals:

1. Proposed schedule.
2. Training agendas for each session.
3. Identification of personnel that will conduct training.
4. Handouts proposed for distribution during training.

F. Field Observation Reports Submittals:

1. Written responses to Field Observation Reports supplied to the Contractor during the course of the Project:
 - a. The response shall include a copy of the original Field Observation Report.
 - b. The response shall include detail of the corrective action taken, the date the action was taken and the identity of the individual who took the action.

G. Closeout Submittals:

1. As-Built Drawings:
 - a. General:
 - 1) Requirements for Shop Drawings apply to “As-Built” drawings.
 - b. Required Drawings:
 - 1) Title Sheet.
 - 2) Floor Plans.
 - 3) System Diagrams.
 - 4) Mounting Details.
 - 5) Labeling Schema.
 - 6) As-built version of each Project shop drawing.
 - c. Drawing Formats:
 - 1) Electronic Editable: Editable version using the native application used to create the file (e.g., Revit, AutoCAD, Star-Draw, Visio, VidCAD).
 - 2) Non-Editable: PDF file format.
 - 3) Printed Hardcopy.
 - 4) Sheets shall be the same size and feature consistent title block information in the lower-right corner.
 - d. Drawing Organization:
 - 1) Hardcopy drawings shall be bound together into logical sets, bound along the left edge of the sheets.
 - 2) The first page of the set shall include a detailed index and sheet-by-sheet description of each drawing sheet.
2. Operation and Maintenance Manuals:
 - a. Manual Format:
 - 1) Hard-cover 3-ring type binder.
 - 2) Front clear plastic cover pocket complete with Project and system Information insert.
 - 3) Clear plastic spine pocket with Project and system Information insert.
 - 4) Binder sized to suit the contents only, neither oversized nor undersized.
 - 5) Maximum binder thickness: 3 inches.
 - b. Manual Contents and Organization:

- 1) General:
 - a) Separate binder (or binder set) for each system, labeled. Provide no more than one system per binder (or binder set).
 - b) Separate CD-ROM (or CD-ROM set) for each system, labeled. Provide no more than one system per CD-ROM (or CD-ROM set).
 - c) Do not overfill. Binders shall not be filled beyond an easily usable capacity.
 - d) Insert labeled tabs within binder to identify separate contents of the manual.
 - e) Labeled sub-directories shall be created on the CD-ROM to label and separate contents for the manual.
- 2) Project Information Cover:
 - a) Title of Project.
 - b) Name and address of Owner, Designer, Architect, Contractor of Record and Subcontractor.
 - c) System name and specification references.
- 3) Index:
 - a) Contents of the manual.
- 4) Warranty Statement:
 - a) A warranty statement shall be included for each system. The warranty statement shall reiterate the terms of warranty identified within the Contract Documents, as well as identify how the Owner is to obtain warranty service.
 - b) The warranty statement shall clearly identify which products are covered by Manufacturer warranties beyond the Contractor required minimum warranty period. The term of manufacturer warranty shall also be identified (e.g., 2 year parts and labor).
 - c) A separate warranty statement shall be supplied for each system.
 - d) Identify the date that the warranty for the system starts. This date shall be the date listed on the Certificate of Substantial Completion (if one was issued to the contractor specifically for the system) or the date listed on the Notice of Final Completion.
 - e) Supply standard out-of-warranty service rates and service contact information.
- 5) Product Datasheets (supply only in the electronic version of Operation and Maintenance Manual):
 - a) Manufacturer datasheets for each product supplied.
- 6) Manufacturer Owner / User Manuals:
 - a) Manufacturer's Owner's or User's manual for each product.
 - b) Manufacturer's Installation instructions and other documentation supplied with the product.
- 7) Test Reports and Checklists:
 - a) Test reports, checklists, and other forms generated and completed during the course of the Project.
- 8) Training Information:
 - a) Photocopy of training outlines / agendas.
 - b) Photocopy of training session handouts.
 - c) Photocopy of training sign-in sheets.
 - d) Photocopy of signed delivery receipt for each training session recording (applicable to those Sections/systems requiring recording).

- 9) As-Built Drawings:
 - a) The hardcopy manual shall contain reduced scale printed version (11x17) of system-specific drawings.
 - b) The electronic manual shall contain electronic PDF version of the as-built drawings.
- 10) Software (electronic manual only):
 - a) Editable configuration files for system equipment.
 - b) Software source code use in supplied products.
 - c) Compiled versions of configuration files and source code.
 - d) Software required for reviewing and editing supplied files.

3.6 QUANTITY

A. General:

1. The quantity of submittals required shall be the greater of the following:
 - a. Quantity identified within Division 01.
 - b. Quantity identified within the individual Section.
 - c. Quantity identified herein.
2. In addition to the Contract required quantity, the Contractor shall also submit any additional quantities required for its own use and records, and for distribution to other trades.
3. The Designer shall retain a copy of each submittal received. Others in the submittal communication chain may also retain copies.

B. Product Data Submittals:

1. Two (2) Hardcopies.
2. One (1) Electronic.

C. Shop Drawings Submittals:

1. Two (2) Hardcopies.
2. One (1) Electronic.

D. Training Submittals:

1. Two (2) Hardcopies.
2. One (1) Electronic.

E. Field Observation Reports Submittals:

1. Two (2) Hardcopies.
2. One (1) Electronic.

F. Pre-Acceptance Submittals:

1. Two (2) Hardcopies.
2. One (1) Electronic.

G. Closeout Submittals:

1. Two (2) Hardcopies.
2. One (2) Electronic.

3.7 REJECTION

A. The following items are representative reasons that submittals may need to be revised and resubmitted:

1. Binding submittals for multiple Sections together.
2. Failing to supply separate transmittal for submittals for each Section.
3. Failing to include a submittal title sheet.
4. Failing to use and accurately complete the published title sheet.
5. Failing to supply and accurately complete the submittal checklists.
6. Failing to supply product data and shop drawings at the same time.
7. Failing to supply product data sheets.
8. Failing to supply product data sheets with the correct product and required accessories enumerated.
9. Failing to supply shop drawings.
10. Failing to supply shop drawings with required information.
11. Failing to supply accurate information.
12. Failing to supply relevant information required by the Specifications.
13. Failing to supply products that are in compliance with the Specifications.
14. Failing to supply the required information in the required format.

3.8 RESUBMITTALS

A. Revise and Resubmit:

1. When a submittal is rejected and flagged as “Revise and Resubmit,” the entire submittal shall be reviewed, revised and resubmitted in totality.
2. Resubmittals shall be checked for compliance with the Contract Documents, inclusive of requirements for submittals. In addition, any comments and deficiencies identified by the reviewer shall be appropriately acted upon.

B. Exceptions Noted:

1. When a submittal is flagged as “Exceptions Noted,” the specific actions identified shall be taken.
2. If the reviewer’s comments include selective rejection of products, the resubmittal shall be limited to include those items commented upon.

C. Resubmittals shall:

1. Include a copy of the reviewer's previous comments.
2. Include a written description of the action(s) taken.
3. Be labeled chronologically.
4. Be inclusive of all corrective action identified by the previous reviewer.

3.9 ELECTRONIC SUBMITTALS

- A. Electronic submittals shall only be permissible where electronic submittals are expressly required and where express approval for such has been granted.
- B. Electronic submittal files shall be compatible for opening and viewing with electronic PDF file readers that fully support and recognize the Adobe PDF Portable Document Format Standard, version 1.5.
- C. Major text within the files shall be electronically searchable using the search-for-text features of current generation Adobe PDF reader software. Files shall be prepared in such manner that reviewers will have the option to search for and find words and phrases that appear within the document, electronically. Documents featuring raster-based text and text that is otherwise not searchable shall not be acceptable. This precludes the use of documents that have been electronically scanned and then converted to or embedded within an electronic file.
- D. The organization, contents, and labeling of information along with other requirements for submittals apply also to electronic versions of the submittals.
- E. Single File Submission:
 1. Option 1 – Single File, PDF Format:
 - a. Single PDF file submittals shall be assembled from a series of individual files that are organized, indexed, bound together as one composite file that is bookmarked to aid the reviewer in navigating the content.
 - b. The file shall feature a navigational tree of contents, organized by content groups (e.g., Title Page, Index, Datasheets, Shop Drawings). Content groups shall be organized in the same relative order identified within the Contract Documents.
 - c. Within each content group shall be the supporting elements of the group (e.g., product datasheets under the Datasheets group). Each element of the content group shall appear separately as a subordinate element of the group (e.g., separate entry for each product datasheet, separate entry for each shop drawing), and viewable from the navigational contents tree.
 - d. Under the Datasheets content group, individual product datasheet entries shall be identified by Make/Brand and Model (e.g., Carrier – 48TJ008 – Gas-Fired Rooftop Unit). Entries shall be organized in a sorted manner, first by make, then by model.
 - e. If the resulting size of the composite PDF file exceeds 10 Megabytes, supply the submittal using the Single Zip File method instead, as described in this Section.
 - f. The file name used to label the submittal shall be the section number followed by the submittal instance number for that Section (e.g., 233113-PD-01.pdf).

- 1) Where the Designer directs the supply of multiple zip files for a submittal, add additional text to the file name to identify that the file is part of a multi-file set of submittals, as per the following examples:
 - a) 233113-PD-01 (1 of 3).pdf
 - b) 233113-PD-01 (2 of 3).pdf
 - c) 233113-PD-01 (3 of 3).pdf
2. Option 2 – Single File, Zip Format:
 - a. Single Zip File submittals shall be assembled from a series of individual PDF files and file directories that are contained with a single compressed WinZip compatible “.zip” file.
 - b. The file shall contain separate top-level directories that are used to group related content (e.g., 00-Title Page, 01-Index, 02-Datasheets, 03-Shop Drawings), with each directory appearing in the same relative order as that identified in the Contract Documents.
 - c. Within each content group directory shall be separate PDF-compliant files featuring the information required (e.g., separate datasheet file for each product, separate file for each drawing, separate file for each shop drawing).
 - d. Product datasheet files shall be named using a consistent naming convention that enables those files to appear sorted and grouped when the file is opened for navigation, viewing or extraction by the reviewer.
 - e. Product datasheet files shall be consistently named with the make/brand of the product, followed by model number, followed by any additional information beneficial (e.g., Carrier – 48TJ008 – Gas-Fired Rooftop Unit).
 - f. Consult the Designer for supplement instructions should the WinZip file exceed 50 Megabytes in size.
 - g. The file name used for the submittal shall be the Section number followed by the submittal instance number for that Section (e.g., 233113-PD-01.zip).
 - 1) Where the Designer directs the supply of multiple zip files for a submittal, add text to the file name that identifies the file is part of a multi-file set as per the following examples:
 - a) 233113-PD-01 (1 of 3).zip
 - b) 233113-PD-01 (2 of 3).zip
 - c) 233113-PD-01 (3 of 3).zip

END OF SECTION 230503

SUBMITTAL TITLE SHEET
EXAMPLE
(Form: Sub-1)

PROJECT TITLE:

Project Name Line 1
Project Name Line 2
Project Name Line 2

SUBMITTAL TYPE:

Product Data

SECTION SUBMITTAL NUMBER

233113-PD-00

SECTION TITLE:

Metal Ducts

Date Prepared:

yyyy-mm-dd

CONTRACTOR OF RECORD:

Firm Name
Address 1
Address 2
City, State, Zip
Phone (000) 000-0000, Fax (000) 000-0000
Project Manager: Full Name
PM E-Mail: xxxxxxxx@xxxx.xxx

SECTION SUBCONTRACTOR(S):

Firm Name Address 1 Address 2 City, State Zip Phone (000) 000-0000 Fax (000) 000-0000 PM Name: Full Name PM E-Mail: xxxxxxxx@xxxx.xx	Firm Name Address 1 Address 2 City, State Zip Phone (000) 000-0000 Fax (000) 000-0000 PM Name: Full Name PM E-Mail: xxxxxxxx@xxxx.xx
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PRODUCT DATA SUBMITTAL

CHECKLIST

(Form: Sub-2)

Each line below featuring text shall be supplied with an answer.

	No	Yes
Transmittal		
Title Sheet.		
Project Name.		
Spec Section number.		
Submittal iteration number. <i>(0 for first iteration, 1 + for each subsequent iteration (e.g. 231513-0,231513-1))</i>		
Contractor of Record identified.		
Sub-contractor / vendor / supplier name identified.		
Title Sheet appearance consistent with sample title sheet.		
Checklists included.		
This checklist.		
Checklists from Section being.		
Previous submittal review, with contractor actions and comments.		
Product Datasheets included.		
Datasheets are manufacturer originals.		
Datasheets for each product included.		
Section paragraph and/or drawing reference on each datasheet.		
Product accessories and options identified.		
Products organized by paragraph (or alphabetically by brand).		
No photocopies, faxes and other illegible datasheets included.		
Shop Drawings included.		
Shop drawings accompany this product data submittal.		
This submittal contains product data for one section only.		

This checklist serves as simple and abbreviated reminder of the contents and format of the aforementioned submittal. Refer to the 23 05 03.00 "Submittals for HVAC" and each specific Section for additional submittal requirements. Submittals are subject to rejection if this checklist is not accurately completed and supplied along with the specified information. Reproduce this checklist and submit with each submittal for each Section.

SECTION 230505 - EXISTING CONDITIONS AND DEMOLITION

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 DESCRIPTION OF WORK

- A. Prior to submitting a bid, the Mechanical Contractor shall perform a detailed walk-through field inspection, to review the existing structures and premises, to determine all existing conditions, equipment/ductwork/piping locations, etc. and shall make all necessary allowances for all required mechanically related demolition and relocation work. This pre-bid inspection by the Mechanical Contractor shall include inspection of all applicable accessible ceiling cavity, areas, etc.
- B. Should the Mechanical Contractor take any exceptions to providing any related demolition or relocation work, such exceptions shall be stated in detail within the Prime Contractor's bid. No subsequent allowance to the contract cost shall be made for any insufficient allowances made by the Mechanical Contractor during bidding which may result from the Mechanical Contractor's failure to visit job site and review drawings.
- C. Demolition related work may not be specifically indicated on drawings, but shall be included under base bid. All mechanically related demolition, relocation, etc. work, including work described herein, shall be under base bid.
- D. It is not the intent of these contract documents that existing conditions be accurately shown. Existing mechanical work is shown to a limited extent on drawings and is shown for general planning reference only. Such locations, etc. have been located from portions of contract documents which were prepared for previously installed work (not from "as-builts"). These locations are not guaranteed. The successful Mechanical Contractor shall have access to all available existing building/system plans and specifications.
- E. Routing of all new ductwork and piping work in existing buildings shall be approved by Owner's representative prior to installation.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 WORK IN EXISTING SPACES

- A. If asbestos, PCB's, or other hazardous materials are encountered in the course of the work, stop work in the vicinity of such materials and report their presence to the Owner. Owner will arrange for proper removal and disposal of hazardous materials.

3.2 GENERAL DEMOLITION

- A. Provide complete mechanical demolition as required for all systems throughout all project areas not indicated to be salvaged or saved. Unless specifically noted otherwise on plans or determined otherwise during this contractor's pre-demolition survey, all abandoned existing mechanical work in the project areas shall be disconnected and removed in its entirety by the Mechanical Contractor. All related work shall comply with the notes specified herein.
- B. Provide demolition work as required to clear and remove all existing mechanical work to be abandoned and as required to accommodate all new work of all trades. In general, remove existing related ductwork, piping, control media, etc. back to nearest concealed accessible terminal or take-off "upstream". Extend ductwork, piping, etc. as required to accommodate new or relocated mechanical work.
- C. Remove abandoned, inactive and obsolete equipment, ductwork, piping, etc. Abandoned work embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove all abandoned materials above accessible ceilings.
- D. Perform cutting and patching required for demolition in accordance with the contract documents.
- E. All abandoned ductwork and piping shall be removed and capped back to respective sources, even if sources are outside of the confines of the project area. Coordinate all work carefully with Owner prior to beginning any mechanical demolition work.
- F. All ductwork, piping, etc. conflicting with construction related work of any and all trades shall be removed and/or relocated by the Mechanical Contractor as necessary and/or as directed by Owner's representative in the field. Mechanical disconnections (and/or reconnections) for equipment to be removed (and/or relocated) shall be by the Mechanical Contractor. This shall apply to all existing mechanical work whether shown on drawings or not.
- G. All refrigerant evacuations and reclaim shall be required for demolished or relocated equipment.

- H. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.
- I. Provide new work as required to accommodate relocations, etc. Routing of all new ductwork and piping in existing buildings shall be held tight to structure above wherever possible and shall be approved by owner's representative prior to installation.

3.3 DISPOSITION OF REMOVED EQUIPMENT & MATERIALS

- A. Except where specifically noted otherwise herein or on drawings, all mechanical work shown on new work plans shall be new.
- B. If required to accommodate construction related activities, remove and reinstall any conflicting fixtures, devices or equipment that are to remain.
- C. All abandoned materials removed during demolition and thereafter shall be referred to the Owner's representative for disposal instructions. All materials which the Owner elects to retain shall be neatly stored at the site by the Mechanical Contractor as designated by the Owner's representative. All materials which the Owner elects not to retain shall be disposed of by the Mechanical Contractor in a lawful manner.
- D. All fixtures, devices or equipment designated for salvage (removal and reuse, or for turning over to Owner) shall be disconnected and removed undamaged. Disconnect all pigtails, etc. from equipment terminal points and carefully transport and neatly store same to a protected on-site storage location as directed in field.
- E. Components to be reused shall be cleaned (inside and out) and reinstalled where indicated on drawings. Modify and/or extend related existing ductwork and/or piping as required.
- F. Components turned over to Owner shall be neatly stored as groups by system type.

3.4 PRE-EXISTING CODE VIOLATIONS

- A. All existing work which is accessed and/or used under this project shall be inspected and brought into compliance with current codes and standards by the Mechanical Contractor. This shall apply only to the extent that such work is uncovered in the immediate project areas affected by demolition and/or new construction and only to the limited extent that it applies to pre-existing general installation methods (i.e. a missing hanger/support, a missing seal and other minor incidental work).
- B. If more extensive code or safety violations are discovered by the Mechanical Contractor, they shall be immediately brought to the attention (detailed in writing) of the Owner's representative along with the contractors proposed cost for corrections.

3.5 INTERIM LIFE SAFETY WORK

- A. Provide interim fire protection (sprinkler) work in all demolition and construction areas for full code coverage. Further definition will be provided in field if required.

3.6 INTERIM INDOOR AIR QUALITY (IAQ) WORK

- A. All requirements of this IAQ subsection shall be implemented prior to commencement of any demolition/construction activities.
- B. No airborne dust or particulate matter shall be permitted to enter any occupied spaces or any air intakes to existing systems.
- C. Become familiar with all affected HVAC systems to ensure that positive pressure can be maintained, relative to construction areas, in all areas adjacent to construction areas. This shall include all possible operational sequences of all systems such, including operation of smoke control, fire dampers, etc.
- D. All return air and exhaust air terminals within all demolition/construction spaces shall be covered and properly sealed until construction is complete.
- E. All air filters shall be checked at the beginning and end of each work shift and shall be changed in-kind as required to permit free airflow at all times.
- F. Provide temporary exhaust throughout all demolition/construction spaces to ensure proper negative pressure is maintained relative to adjacent areas, including allowances for normal construction traffic through all access doors. Ensure that no windows or doors are left open which could upset the desired negative pressure.
- G. Designate a dedicated qualified person to be on site to monitor all IAQ requirements, including checking filters three to four times per shift, checking for any breeches (by any contractor) such as drilled/cut openings in walls/floors, open windows, etc. Ensure that openings through walls and floors (by any contractor) are made immediately prior to installation of work and properly/permanently sealed immediately thereafter.

END OF SECTION 230505

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC

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. Motors Furnished with HVAC Equipment
- B. Related Sections:
 - 1. Section 23 05 03.00 "Submittals for HVAC"

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 3. Clearly state equipment markings (i.e. AHU-1), capacities, voltages and model numbers on all submittals.
- B. Shop Drawings:
 - 1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: drawings and details, drawn to scale, on which all items, including other trades, are shown and coordinated with each other, code required clearances, manufactured recommended service clearances, using input from installers of the items involved.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For equipment to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Comply with NFPA 70, "National Electrical Code"

1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components of equipment that fail(s) in materials or workmanship within specified warranty period.

1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. All mechanical equipment shall be UL listed for use with "HACR" circuit breakers.
- B. The motor control apparatus shall be furnished complete as a part of the motor and apparatus which it operates when called for in certain instances in the Mechanical Division. Motor control apparatus except as above shall be complete, factory wired and tested, ready for connections to be made under Division 26.

2.2 MOTORS

- A. All motors shall be in accordance with the latest standards of NFPA 70, "National Electrical Code".
- B. Refer to HVAC/Electrical Coordination Schedule and the Electrical specifications and drawings for the exact voltage of motors.
- C. Wherever in these specifications, a motor voltage is listed, the motor shall be wound for the listed voltage and none other will be accepted.
- D. Service Factors indicated for motors are minimum values and apply at frequency and utilization voltage at which motor is connected. Provide motors, which will operate in the service factor range when supply voltage is within 10 percent of motor voltage rating.

- E. For motors controlled with a variable frequency drive, provide grounding rings and brushes on motor shaft to divert shaft to ground current flow around bearings.
- F. Temperature Rise: Based on 100 degree F ambient except as otherwise indicated.
- G. Three-Phase Motors
 - 1. Squirrel cage induction type.
 - 2. NEMA design letter Designation "B".
 - 3. Internal thermal overload protection.
 - 4. Bearings: double shielded, prelubricated, regreasable.
 - 5. Energy Efficient Motors: equal or greater than NEMA MG-1.
 - 6. 1.25 Service factor.
 - 7. Multi Speed Motors: separate windings for each speed.
- H. Single-Phase Motors
 - 1. Internal thermal overload protection.
 - 2. Motor starters incorporated as an integral part of equipment shall be NEMA standard.
 - 3. Sealed, prelubricated bearings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine products or materials before installation. Reject products or materials that are wet, moisture damaged, or mold damaged.
- C. Examine walls, floors, roofs, and equipment for suitable conditions where equipment will be installed.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ELECTRICAL INSTALLATION

- A. All electrical work associated with this section shall be in accordance with the latest standards of NFPA 70, "National Electrical Code".

- B. Electrical wiring shall be provided under Division 26 unless specifically called for in another section of the specifications.
- C. An enclosed safety type, NEMA Type HD motor disconnect switch shall be furnished and installed for each motor installation unless specifically mentioned as furnished under another section of these specifications.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Inspection: Arrange and pay for a factory-authorized service representative to perform the following:
 - 1. Prepare a written report on findings and recommended corrective actions if any are required.

3.4 STARTUP PROCEDURES

- A. Energize motor, verify proper operation of motor, drive system, and fan wheel.
- B. Measure and record motor electrical values for voltage and amperage.

3.5 MOTOR ADJUSTMENT

- A. Adjust hardware and moving parts to function smoothly, and lubricate as recommended by manufacturer.

3.6 PROTECTION

- A. Remove and replace products or materials that are wet, moisture damaged, or mold damaged.

END OF SECTION 230513

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

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 pipe hangers and supports
2. Trapeze pipe hangers
3. Metal framing systems
4. Thermal-hanger shield inserts
5. Fastener systems
6. Equipment supports

- B. Related Sections:

1. Section 055000.00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 230503.00 "Submittals for HVAC".
3. Section 233113.00 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines to Terminology for Pipe Hangers and Supports"

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified structural professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping, and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Metal pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Powder-actuated fastener systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers including product data for components
2. Metal framing systems including product data for components
3. Equipment supports

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Copper Pipe Hangers:

1. Nonmetallic Coatings: Plastic coating, jacket, or liner for hangers in contact with copper piping.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

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

1. Anvil International, Inc.
2. B-Line Systems, Inc. (a division of Cooper Industries)
3. ERICO/Michigan Hanger Company
4. PHD Manufacturing, Inc

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100 psig minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ERICO International Corporation.
 2. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 3. Rilco Manufacturing Co., Inc.
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 552, Type II cellular glass with vapor barrier.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head
 - c. Masterset Fastening Systems, Inc
 - d. MKT Fastening, LLC

- e. Powers Fasteners.

- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. B-Line Systems Inc. (a division of Cooper Industries)
 - b. Empire Industries
 - c. Hilti, Inc
 - d. ITW Ramset/Red Head
 - e. MKT Fastening, LLC
 - f. Powers Fasteners

2.5 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.6 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. General: Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible. Where piping of various sizes is supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.

- B. Do not suspend hangers from roof decks. Suspend from roof trusses, joists and joist girders only at panel points and at top chords unless otherwise indicated.

- C. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- D. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- E. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- F. Use padded hangers for piping that is subject to scratching.
- G. All mechanical equipment shall have concrete bases and/or structural steel supports and shall be provided by this contractor.
- H. The use of equipment as piping supports shall be prohibited. All such connectors and their supports shall be independently supported from the building structure and inspected and approved by the Engineer before bolting.
- I. Piping connections to all equipment with moving parts shall be isolated with braided copper or stainless steel flexible links, which shall be selected to absorb the deflection on the isolating members.
- J. Use thermal-hanger shield inserts for insulated piping and tubing.
- K. Hangers: Provide adjustable, Steel Clevis Hangers (MSS Type 1) for suspension of noninsulated or insulated, stationary pipes.
- L. Horizontal-Piping Clamps: Provide Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3) for suspension of pipes requiring clamp flexibility and up to 4 inches of insulation.
- M. Vertical-Piping Clamps: Provide extension pipe or Riser Clamps (MSS Type 8) for support of pipe risers.
- N. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
- O. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Inserts:
 - a. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Clamps:
 - a. C-Clamps (MSS Type 23): For structural shapes.
 - b. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 3. Miscellaneous:
 - a. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 - b. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - 1) Light (MSS Type 31): 750 lb.
 - 2) Medium (MSS Type 32): 1500 lb.
 - 3) Heavy (MSS Type 33): 3000 lb.
 - c. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 - d. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- P. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 2. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- Q. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- S. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- T. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- U. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- V. Fastener System Installation:

1. Verify suitability of fasteners in two subparagraphs below for use in lightweight concrete or concrete slabs less than 4 inches thick.
 2. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 3. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- W. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- X. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- Y. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- Z. Install lateral bracing with pipe hangers and supports to prevent swaying.
- AA. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, guides, expansion joints, strainers and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- BB. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- CC. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- DD. Insulated Piping:
1. Attach clamps and spacers to piping.
 - a. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation. Do not exceed pipe stresses allowed by manufacturer.
 - b. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - c. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - d. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 2. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

- a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Shields:
 - a. Install protective galvanized steel shields, MSS Type 40, on insulated piping smaller than 2-inch NPS. Shields shall span an arc of 180 degrees and shall be a minimum of 12-inches in length.
 - b. Install thermal-hanger shield inserts on all insulated piping 2-inch NPS and larger.
4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.
- D. Concrete bases shall extend at least 4" beyond the bed or frame of the supported machine. Equipment bases shall have straight and finished sides and a 1"-45 degree chamfer at the top. Reinforcing steel bars (Type #4) shall be placed in a grid pattern in both directions of the base spaced at 12" on center.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports. Install and align fabricated anchors in indicated locations.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Piping:

Piping Material	Pipe Size	Hanger Spacing (OC)
Copper	1" and smaller	6'-0"
Copper	1-1/4" and larger	8'-0"

- 1. In addition to supported pipe information above, support piping at each change in direction.

END OF SECTION 230529

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

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. Warning signs and labels.
 - 2. Equipment labels.
 - 3. Pipe labels.
 - 4. Duct labels.
- B. Related Sections:
 - 1. Section 23 05 03.00 "Submittals for HVAC".

1.3 QUALITY ASSURANCE

- A. Comply with ASTM E84
- B. Comply with ASME A13.1 Scheme for the Identification of Piping Systems.
- C. Comply with University of Kentucky Standard Color Coding for Mechanical Piping

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

1.5 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.

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

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. General: Subject to compliance with requirements, provide mechanical identification materials of one of the following:
 1. Brady (W.H.) Co., Signmark Div.
 2. Brimar
 3. Seton Name Plate Corp.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 1. Size: Approximately 4 by 7 inches.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 4. Color: Yellow background with black lettering.
- C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- E. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- F. Fasteners: Stainless-steel rivets or self-tapping screws.
- G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.4 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. For piping less than NPS 6, Provide full-band pipe markers, extending 360 degrees around pipe, fastened by one of the following:

1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
 2. Adhesive lap joint in pipe marker overlap.
 3. Laminated or bonded application of pipe marker to pipe or insulation.
 4. Taped to pipe or insulation with color-coded plastic adhesive tape, not less than $\frac{3}{4}$ " wide; full circle at both ends of pipe marker, tape lapped 1-1/2".
- C. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 2. Lettering Size: At least 1-1/2 inches high.

2.5 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch or 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: White.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

3.3 EQUIPMENT LABEL INSTALLATION

- A. The contractor shall provide labeling for each piece of equipment above the ceiling. Labeling shall be on ceiling grid (not ceiling tile) below the equipment. The label shall match the equipment identification shown on the drawings sheet.
- B. General: Install engraved plastic laminate sign on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device.
- C. Install or permanently fasten labels on each major item of mechanical equipment.
- D. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. General: Install pipe markers on each system of flow, provide type and temperature identification, and include arrows to show normal direction of flow:
 1. Heating (200 degrees F) Supply Return
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Color Schedule:

1. Refrigerant Piping:
 - a. Background Color: White.
 - b. Letter Color: Brown.
2. Air conditioning Condensate Piping
 - a. Background Color: White.
 - b. Letter Color: Green.

3.5 DUCT LABEL INSTALLATION

- A. General: Identify air supply, return, exhaust, intake and relief ductwork with tags and arrows, showing ductwork service and direction of flow, in black or white (whichever provides most contrast with ductwork color).
- B. Install plastic-laminated self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
 1. Blue: For cold-air supply ducts.
 2. Red: For hot-air supply ducts.
 3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
 4. ASME A13.1 Colors and Designs: For hazardous material exhaust.
- C. Location: In each space where ductwork is exposed, or concealed only by removable ceiling system, locate signs near points where ductwork originates or continues into concealed enclosures (shaft, underground or similar concealment), and at 50' spacings along exposed runs. Identification shall be applied only to new work.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING AND BALANCING FOR HVAC

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 specifies the requirements and procedures total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results.
- B. Test, adjust, and balance the following mechanical systems:
 - 1. Supply, return, exhaust and outside air systems for all pressure classes.
 - 2. Additional Tests
- C. Related Sections:
 - 1. Section 23 05 03 "Submittals for HVAC".

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council
- B. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- C. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.
- D. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
- E. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
- F. NC: Noise criteria.

- G. NEBB: National Environmental Balancing Bureau
- H. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- I. RC: Room criteria.
- J. Report Forms: Test data sheets for recording test data in logical order.
- K. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
- L. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- M. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- N. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- O. TAB: Testing, adjusting, and balancing.
- P. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- Q. Test: A procedure to determine quantitative performance of systems or equipment.
- R. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 ACTION SUBMITTALS

- A. Agency Data
 - 1. Submit proof that the proposed testing, adjusting, and balancing agency meets the qualifications specified below.
- B. Maintenance Data: Submit maintenance and operating data that include how to test, adjust, and balance the building systems. Include this information in maintenance data specified in Division 1.

- C. Certified Reports: Submit testing, adjusting, and balancing reports bearing the seal and signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below:
1. Final Report: Upon verification and approval prepare final reports, type written, and organized and formatted as specified below. Submit 2 complete sets of final reports.
 2. Report Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the below listed divisions, separated by divider tabs:
 - a. General Information and Summary
 - b. Air Systems
- D. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit 6 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- E. Contract Documents Examination Report: Within 30 days from Contractor's Notice to Proceed, submit 6 copies of the Contract Documents review report as specified in Part 3.
- F. Strategies and Procedures Plan: Within 60 days from Contractor's Notice to Proceed, submit 6 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.
- G. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.
- H. Sample Report Forms: Submit two sets of sample TAB report forms.

1.5 QUALITY ASSURANCE

- A. Codes and Standards:
1. AABC: "National Standards for Total System Balance".
 2. ASHRAE: ASHRAE Handbook, Systems Volume, Chapter 37, Testing, Adjusting, and Balancing.
- B. Agency Qualifications

1. The HVAC Contractor shall procure the services of an independent Balance and Testing Agency, approved by the Engineer, and a member of Associated Air Balance Council (AABC) or NEBB, which specializes in the balancing and testing of heating, ventilating, and air conditioning systems, to balance, adjust and test all air and water systems and equipment as herein specified.
 2. All work by this agency shall be done under direct supervision of a qualified heating and ventilating Engineer employed by this agency.
 3. All instruments used by this agency shall be accurately calibrated and maintained in good working order.
- C. The Balance and Testing Agency must provide the technicians with the following instruments for field use:
1. One set of pressure gages and fittings.
 2. Dry bulb thermometer.
 3. Wet bulb thermometer.
 4. Thermocouple unit and thermocouples.
 5. Set of balancing cock adjustment wrenches.
 6. Portable field flowmeter.
- D. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.
- E. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.
1. Agenda Items: Include at least the following:
 - a. Submittal distribution requirements.
 - b. The Contract Documents examination report.
 - c. TAB plan.
 - d. Work schedule and Project-site access requirements.
 - e. Coordination and cooperation of trades and subcontractors.
 - f. Coordination of documentation and communication flow.
 2. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
 - a. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - b. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.
- F. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems." NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems." SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing." TAB firm's forms approved by Architect.

- G. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems NEBB's " Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems, " Section II, " Required Instrumentation for NEBB Certification."
- H. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
 - 1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.6 SEQUENCING AND SCHEDULING

- A. Systems shall be fully operational prior to beginning procedures.
- B. Test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within 5 deg F wet bulb temperature of maximum summer design condition, and within 10 deg F dry bulb temperature of minimum winter design condition. Take final temperature readings during seasonal operation.

1.7 PROJECT CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.8 UNIVERSITY REQUIREMENTS

- A. The tab report is to be signed and stamped by a registered professional engineer.
- B. The tab contractor is to be independent of other related project contractors.
- C. The tab contractor will conduct an inspection of the mechanical installation at 30% and 70% completion. A report on the installation will be given to the prime contractor listing items to be corrected and addressed prior to the tab contractor beginning tab work.
- D. The tab field work is to be conducted in both the heating and cooling mode of operation. This may require the tab contractor to return to the site after the seasonal changeover.
- E. The materials, equipment and representative system tests should be witnessed by the University and the engineer. The names of the witnesses are to be listed on the test results.

- F. The tab report is to be in a letter size binder with cover and edge title, introduction information, index, a set of drawings, equipment identification, data sheets, etc. A tab report is to accompany each M&O manual required.
- G. Testing and balancing shall be performed only after all equipment and controls have been installed and all systems are 100 percent functional.
- H. All corrections of problems discovered by the TAB shall be corrected immediately by the responsible contractor and the system retested for compliance with contract documents.

1.9 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- C. Perform TAB after leakage and pressure tests on air distribution systems have been satisfactorily completed.

1.10 GUARANTEE

- A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents.
- B. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:
 - 1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
 - 2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 GENERAL

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper testing and balancing of systems and equipment.
- B. Examine systems for installed balancing devices, such as manual volume dampers. Note the locations of devices that are not accessible for testing and balancing.
- C. Examine the reviewed submittals for HVAC systems and equipment.
- D. Examine system and equipment installations and verify that field quality control testing, cleaning and adjusting specified in individual system and equipment Sections.
- E. Examine HVAC equipment and verify that bearings are greased and equipment with functioning controls are ready for operation.
- F. Report deficiencies discovered before and during performance of the testing and balancing procedures. Observe and record system reactions to changes in conditions. Record default setpoints if different from indicated values.

3.2 PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING

- A. Examine equipment performance data including fan curves.
- B. Check filters for cleanliness.
- C. Check dampers (both volume and fire) for correct and locked position, and temperature control for completeness of installation before starting fans.
- D. Place outlet dampers in the full open position.
- E. Lubricate all motors and bearings
- F. Check fan rotation
- G. Air balance and testing shall not begin until the system has been completed and is in full working order. The Contractor shall put all heating, ventilating and air conditioning systems and equipment into full operation and shall continue the operation of same during each working

day of testing and balancing. The contractor shall submit within 30 days after receipt of contract, 8 copies of submittal data for the testing and balancing of the air conditioning, heating, and ventilating systems. The Air Balance and Testing Agency shall provide proof of having successfully completed at least five projects of similar size and scope.

3.3 PREPARATION

- A. Prepare a testing and balancing plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.

- B. Prepare system-readiness checklists, as described in the "AABC National Standards for Total System Balance," for use by systems installers in verifying system readiness for T&B. These shall include, at a minimum, the following:
 - 1. Airside:
 - a. Ductwork is complete with terminals installed.
 - b. Volume, smoke and fire dampers are open and functional.
 - c. Clean filters are installed.
 - d. Fans are operating, free of vibration, and rotating in correct direction.
 - e. Automatic temperature-control systems are operational.
 - f. Ceilings are installed.
 - g. Windows and doors are installed.
 - h. Suitable access to balancing devices and equipment is provided.

3.4 MEASUREMENTS

- A. Provide all required instrumentation to obtain proper measurements, calibrated to the tolerances specified in the referenced standards. Instruments shall be properly maintained and protected against damage.

3.5 PERFORMING TESTING, ADJUSTING, AND BALANCING

- A. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards.

- B. Cut insulation, ductwork, and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
 - 1. Patch insulation, ductwork, and housings, using materials identical to those removed.
 - 2. Seal ducts after testing. Then test for leaks and repair if found.
 - 3. Seal insulation to re-establish integrity of the vapor barrier.

- C. Mark equipment settings, including damper control positions, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.
- D. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

3.6 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain approved submittals and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare single-line schematic diagram of systems for the purpose of identifying HVAC components.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check condensate drains for proper connections and functioning.

3.7 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Set outside air, return air and relief air dampers for proper position that simulates minimum outdoor air conditions.
 - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 - 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.

- c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report any artificial loading of filters at the time static pressures are measured.
 3. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
 1. Measure airflow of submain and branch ducts.
 2. Adjust sub-main and branch duct volume dampers for specified airflow. Re-measure each sub-main and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
 1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 2. Measure airflow at all inlets and outlets.
 3. Adjust each inlet and outlet for specified airflow.
 4. Re-measure each inlet and outlet after all have been adjusted.
- D. Verify final system conditions.
 1. Re-measure and confirm minimum outdoor air, return and relief airflows are within design. Readjust to design if necessary.
 2. Re-measure and confirm total airflow is within design.
 3. Re-measure all final fan operating data, rpms, volts, amps, static profile.
 4. Mark all final settings.
 5. Test system in economizer mode. Verify proper operation and adjust, if necessary.
 6. Measure and record all operating data.
 7. Record final fan-performance data.

3.8 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 1. Manufacturer's name, model number, and serial number.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Phse/Hertz (Hz)
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter size and thermal-protection-element rating.
 8. Service factor and frame size.

- B. Motors Driven by Variable-Frequency Controllers: Test the manual bypass of the controller to prove proper operation.

3.9 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record fan and motor operating data.

3.10 FINAL TEST AND BALANCE REPORT

- A. The report shall be a complete record of the HVAC system performance, including conditions of operation, items outstanding, and any deviations found during the T&B process. The final report also provides a reference of actual operating conditions for the owner and/or operations personnel. All measurements and test results that appear in the reports must be made on site and dated by the AABC technicians or test and balance engineers.
- B. The report must be organized by systems and shall include the following information as a minimum:
 - 1. Title Page:
 - a. AABC certified company name
 - b. Company address
 - c. Company telephone number
 - d. Project identification number
 - e. Location
 - f. Project Architect
 - g. Project Engineer
 - h. Project Contractor
 - i. Project number
 - j. Date of report
 - k. AABC Certification Statement
 - l. Name, signature, and certification number of AABC TBE
 - 2. Table of Contents.
 - 3. AABC National Performance Guaranty.
 - 4. Report Summary:
 - a. The summary shall include a list of items that do not meet design tolerances, with information that may be considered in resolving deficiencies.
 - 5. Instrument List:
 - a. Type.
 - b. Manufacturer.
 - c. Model.
 - d. Serial Number.

- e. Calibration Date.
- 6. T&B Data:
 - a. Provide test data for specific systems and equipment as required by the most recent edition of the "AABC National Standards."
- C. One copy of the final test and balance report shall be sent to the engineer of record. Provide five additional copies to the contractor.

3.11 VERIFICATION OF T&B REPORT

- A. Final Verification:
 - 1. After testing and balancing is complete and accurately documented in the final report, request that a final verification be made by the engineer of record
 - 2. The engineer of record shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
 - 3. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
 - 4. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final verification, the testing and balancing shall be considered incomplete.

3.12 REVERIFICATION

- A. T&B Agency shall recheck all measurements and make adjustments as required to complete the balancing. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second verification.
- B. If the second verification also fails, the engineer of record may contact AABC Headquarters regarding the AABC National Performance Guaranty.

3.13 ADDITIONAL TESTS

- A. Seasonal Periods: If initial T&B procedures were not performed during near-peak conditions, the engineer of record may request a temperature recheck to further verify performance at near-peak conditions.
- B. Sound Testing
 - 1. After the systems are balanced and the spaces are architecturally complete, read and record sound levels at 10 locations as designated by the engineer of record.
 - 2. Instrumentation:

- a. The sound-testing meter shall be a portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.
 - b. The sound-testing meter shall be capable of showing fluctuations at minimum and maximum levels, and measuring the equivalent continuous sound pressure level (LEQ).
 - c. The sound-testing meter must be capable of using 1/3 octave band filters to measure mid-frequencies from 31.5 HZ to 8000 HZ.
 - d. The accuracy of the sound-testing meter shall be ± 1 decibel.
3. Test Procedures
- a. Perform test at the quietest background noise period. Note any cause of unpreventable sound that may affect the test outcome.
 - b. Equipment should be operating at design values.
 - c. Calibrate the sound-testing meter prior to taking measurements.
 - d. Use a microphone suitable for the type of noise levels measured that is compatible with the meter. Provide a windshield for outside or in-duct measurements.
 - e. Record a set of background measurements in dB(A), and sound pressure levels in the eight un-weighted octave bands 63 HZ to 8000 HZ (NC) with the equipment off.
 - f. Take sound readings in dB(A), and sound pressure levels in the eight un-weighted octave bands 63 HZ to 8000 HZ (NC) with the equipment on.
 - g. Take readings no closer than 3' from a wall or from the operating equipment, and approximately 5' from the floor, with the meter held or mounted on a tripod.
 - h. For outdoor measurements, move the sound-testing meter slowly and scan the area that has the greatest exposure to the noise source being tested. (This type of reading is generally performed using the A-Weighted scale).
4. Reporting
- a. The report must record: the location, the system tested, the dB(A) reading, and the sound pressure level in each octave band with equipment on and off.
 - b. Plot all the sound pressure levels on the NC work sheet, with the equipment on and off.
- C. Duct Leakage Testing:
1. Witness the duct pressure testing performed by the mechanical/installing contractor.
 2. Verify that proper test methods are used and that leakage rates are within specified tolerances.
 3. Report any deficiencies observed.
- D. Controls Verification
1. In conjunction with system balancing perform the following:
 - a. Work with the temperature control contractor to ensure the system is operating within the design limitations, and gain a mutual understanding of intended control performance.
 - b. Confirm that the sequences of operation are in compliance with the approved drawings.
 - c. Verify that controllers are calibrated and function as intended.

- d. Verify that controller setpoints are as specified.
 - e. Verify the operation of lockout or interlock systems.
 - f. Verify the operation of all valve and damper actuators.
 - g. Verify that all controlled devices are properly installed and connected to the correct controller.
 - h. Verify that all controlled devices travel freely and are in the position indicated by the controller: open, closed, or modulating.
 - i. Verify the location and installation of all sensors to ensure they will sense only the intended temperatures, humidities, or pressures.
2. Reporting
- a. The report shall include a summary of verifications performed, remaining deficiencies, and any variations from specified conditions.

END OF SECTION 230593

SECTION 230713 - DUCT INSULATION

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 insulating the following duct services:

- 1. HVAC Ductwork.

- B. Related Sections:

- 1. Section 23 05 03 "Submittals for HVAC".
- 2. Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment".
- 3. Section 23 31 13 "Metal Ducts".

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

- B. Schedule: Submit schedule showing insulation products which will be used for each application, indicating thickness, density, and accessories.

- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

- 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
- 2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
- 3. Detail application at linkages of control devices.

- D. Schedule: Submit schedule showing insulation products which will be used for each application, indicating thickness, density, installed R-values and accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.

- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ANSI/ASTM E 84 and NFPA 255, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
- C. Installed R-Values for insulation on ducts shall comply with local mechanical and energy code as required for indoor applications.
- D. Insulation tape shall comply with UL 181.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing duct systems. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 DUCTWORK INSULATION MATERIALS

A. Manufacturers

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corp.; SoftTouch Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Friendly Feel Duct Wrap.
 - d. Owens Corning; SOFTR All-Service Duct Wrap.
 - e. Thermaduct, LLC

- B. Interior (indoor) ductwork insulation shall have a minimum installed thermal resistance value of R6 or code minimum, whichever higher.

- C. Products shall not contain asbestos, lead, mercury, or mercury compounds.

- D. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, without facing and with vapor barrier Type II with factory-applied kraft paper, reinforcing scrim, aluminum foil and vinyl jackets.

- E. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB. For duct and plenum applications, provide insulation without facing and with vapor barrier with factory-applied kraft paper, reinforcing scrim, aluminum foil and vinyl jacket.

- F. Vapor Barrier Material for Ductwork: Paper-backed aluminum-foil, except as otherwise indicated; strength and permeability rating equivalent to factory-applied vapor barriers on adjoining ductwork insulation, where available; with following additional construction characteristics:

- 1. High Puncture Resistance: Low vapor transmission (for ducts in exposed, high traffic areas susceptible to damage: Mech. Rooms, etc.)
- 2. Moderate Puncture Resistance: Medium vapor transmission (for ducts in concealed areas).

- G. Ductwork Insulation Accessories: Staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.

- H. Ductwork Insulation Compounds: Cements, mastics, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- C. Maintain integrity of vapor-barrier on ductwork insulation, and protect it to prevent puncture and other damage.
- D. Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise indicated
- E. Lined Ductwork: Except as otherwise indicated, omit insulation on ductwork where internal insulation or sound absorbing linings have been installed. Duct lining thermal resistance value shall comply with external duct wrap requirements.
- F. Corner Angles: Install corner angles on external corners of insulation on ductwork in exposed finished spaces.
- G. Provide insulation on collar and backside of supply diffusers in all ceiling spaces. Provide insulation on plenum box of all supply grilles and registers in all ceiling spaces.

- H. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- I. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- J. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- K. Install multiple layers of insulation with longitudinal and end seams staggered.
- L. Keep insulation materials dry during application and finishing.
- M. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- N. Install insulation with least number of joints practical.
- O. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- P. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- Q. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- R. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- S. Do not overly compress insulation which will result in decreased thermal resistance properties. Install insulation as recommended by the insulation manufacturer.
- T. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Outside Air and/or Exhaust:
 - a. HVAC Ductwork (Outside Air) between outside air entrance and fan inlet or HVAC unit inlet.
 - b. HVAC Ductwork (Outside Air and Exhaust) in a location where the ambient air will be 15 degrees greater or less than the internal duct air temperature.
 - c. HVAC Louvers, Plenums and Ductwork three feet downstream of wall penetrations.
2. Supply and/or Return:
 - a. HVAC Ductwork (Supply) between fan discharge, or HVAC unit discharge, and room terminal outlet(s).
 - b. HVAC Ductwork (Supply & Return) in a location where the ambient air will be 15 degrees greater or less than the internal duct air temperature.
 - c. HVAC Ductwork (Supply & Return) located in un-insulated joist or attic space.

B. Grilles, Registers, and Diffusers:

1. Provide insulation on collar and backside of supply diffusers in all ceiling spaces. Provide insulation on plenum box of all supply grilles & registers in all ceiling spaces.

C. Items Not Insulated:

1. Fibrous-glass ducts.
2. Fabric ductwork.
3. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
4. Factory-insulated flexible ducts.
5. Factory-insulated plenums and casings.
6. Flexible connectors.
7. Vibration-control devices.
8. Factory-insulated access panels and doors.
9. HVAC Ductwork (Supply) exposed in conditioned spaces.

3.5 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

C. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.

3.6 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each duct system defined in the "Duct Insulation Schedule, General" Article.

- B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.7 PROTECTION AND REPLACEMENT

- A. Repair damaged vapor barrier using vapor barrier tape to fully cover torn area.

- B. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

- C. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION 230713

SECTION 230719 - HVAC PIPING INSULATION

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 insulating the following HVAC piping systems:

1. Air Conditioning Condensate drain piping.
2. Refrigerant suction and hot-gas piping.

- B. Related Sections:

1. Section 23 05 03 "Submittals for HVAC".
2. Section 23 07 13 "Duct Insulation."
3. Section 23 07 16 "HVAC Equipment Insulation."

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

- C. Schedule: Submit schedule showing insulation products which will be used for each application, indicating thickness, density, and accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ANSI/ASTM E 84 and NFPA 255, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pittsburgh Corning Corporation; Foamglas.
 - 2. Block Insulation: ASTM C 552, Type I.
 - 3. Special-Shaped Insulation: ASTM C 552, Type III.
 - 4. Board Insulation: ASTM C 552, Type IV.
 - 5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 - 6. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
 - 7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I without slits for tubular materials.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Armacell LLC; AP Armaflex.

- H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type II with factory-applied vinyl jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; SoftTouch Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Friendly Feel Duct Wrap.
 - d. Owens Corning; SOFTR All-Service Duct Wrap.

- I. Mineral-Fiber, Preformed Pipe Insulation:
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Micro-Lok.
 - b. Knauf Insulation; 1000-Degree Pipe Insulation.
 - c. Owens Corning; Fiberglas Pipe Insulation.

- J. Vapor Barrier Material: Paper-backed aluminum foil, except as otherwise indicated, strength and permeability rating equivalent to adjoining pipe insulation jacketing

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Ramco Insulation, Inc.; Super-Stik.

- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Ramco Insulation, Inc.; Thermokote V.

- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

- B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.

- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA, Inc.; Aero seal.
 - b. Armacell LLC; Armaflex 520 Adhesive.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
 - d. K-Flex USA; R-373 Contact Adhesive.

- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
 - d. Mon-Eco Industries, Inc.; 22-25.

- E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
 - d. Mon-Eco Industries, Inc.; 22-25.

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

- B. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.

- b. Eagle Bridges - Marathon Industries; 501.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
 - d. Mon-Eco Industries, Inc.; 55-10.
2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
 3. Service Temperature Range: 0 to 180 deg F.
 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
 - b. Eagle Bridges - Marathon Industries; 550.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
 - d. Mon-Eco Industries, Inc.; 55-50.
 - e. Vimasco Corporation; WC-1/WC-5.
 2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 4. Solids Content: 60 percent by volume and 66 percent by weight.
 5. Color: White.

2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
 - c. Vimasco Corporation; 713 and 714.
 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 3. Service Temperature Range: 0 to plus 180 deg F.
 4. Color: White.

2.6 SEALANTS

- A. Joint Sealants:

1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Eagle Bridges - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Pittsburgh Corning Corporation; Pittseal 444.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Approved equal
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
3. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
 - 2) Approved equal
4. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; 20 mil thickness; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 - 2. Adhesive: As recommended by jacket material manufacturer.
 - 3. Color: White.
 - 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABI, Ideal Tape Division; 428 AWF ASJ.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
 - c. Compac Corporation; 104 and 105.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 - 2. Width: 3 inches.
 - 3. Thickness: 11.5 mils.
 - 4. Adhesion: 90 ounces force/inch in width.
 - 5. Elongation: 2 percent.
 - 6. Tensile Strength: 40 lbf/inch in width.
 - 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABI, Ideal Tape Division; 491 AWF FSK.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.

- c. Compac Corporation; 110 and 111.
 - d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
2. Width: 3 inches.
 3. Thickness: 6.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABI, Ideal Tape Division; 370 White PVC tape.
 - b. Compac Corporation; 130.
 - c. Venture Tape; 1506 CW NS.
 2. Width: 2 inches.
 3. Thickness: 6 mils.
 4. Adhesion: 64 ounces force/inch in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABI, Ideal Tape Division; 488 AWF.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
 - c. Compac Corporation; 120.
 - d. Venture Tape; 3520 CW.
 2. Width: 2 inches.
 3. Thickness: 3.7 mils.
 4. Adhesion: 100 ounces force/inch in width.
 5. Elongation: 5 percent.
 6. Tensile Strength: 34 lbf/inch in width.
- E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.
 - b. Approved equal
 2. Width: 3 inches.
 3. Film Thickness: 4 mils.
 4. Adhesive Thickness: 1.5 mils.
 5. Elongation at Break: 145 percent.
 6. Tensile Strength: 55 lbf/inch in width.

2.10 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ITW Insulation Systems; Gerrard Strapping and Seals.
 - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

C. Wire: 0.080-inch nickel-copper alloy.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C & F Wire.

PART 3 - EXECUTION

3.1 EXAMINATION

- #### A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- #### A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- #### B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- #### C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- #### A. Install insulation on pipe systems subsequent to testing and acceptance of tests.

- B. Repair or replace damaged existing insulation as indicated or required.
- C. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties. Do not use cut pieces or scraps abutting each other.
- D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- E. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.
- F. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.
- G. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.
- H. Provide continuous insulation through hangers, straps and all other supporting members.
- I. Provide PVC jacketing around all piping and fittings that are exposed within building, not including mechanical rooms or equipment closets.
- J. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- K. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- L. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- M. Install multiple layers of insulation with longitudinal and end seams staggered.
- N. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- O. Keep insulation materials dry during application and finishing.
- P. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- Q. Install insulation with least number of joints practical.

- R. Encase pipe fittings insulation with one-piece pre-molded PVC fitting covers.
- S. Install protective metal shields and thermal hanger shield inserts at all supporting members to prevent compression of insulation. Refer to Section “Hangers And Supports For HVAC Piping And Equipment.”
- T. Flexible Closed Cell Elastomeric Installation: Slide full sections of insulation onto pipe. Do not slit pipe to fit around piping. All edges shall be clean cut. Insulation shall be pushed onto pipe, never pulled. All seams and butt joints shall be adhered and sealed using adhesive equal to Armaflex 520 Adhesive.
- U. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- V. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- W. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- X. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

- Y. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- Z. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- AA. For above-ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- D. Insulation Installation at Floor Penetrations:
 - 1. Pipe: Install insulation continuously through floor penetrations.
 - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- 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 Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.

2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.
- D. Where PVDC jackets are indicated, install as follows:
1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
 2. Wrap factory-presize jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presize jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
 3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
 4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
 5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.10 FINISHES

- A. Pipe Insulation with ASJ, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.

- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.12 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

3.13 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces.

2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.14 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.

B. Refrigerant Suction and Hot-Gas Piping:

1. Insulation shall flexible elastomeric be the following minimum thickness:
 - a. NPS 3/4 and smaller: 3/4 inch thick.
 - b. NPS 1 to NPS 4: 1 inch thick.
2. For ductless split systems insulate refrigerant suction and liquid lines between evaporators and condensing units. Insulate each line separately.
3. For refrigeration suction lines, insulate between evaporators and compressors.

C. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. Insulation shall flexible elastomeric be the following minimum thickness:
 - a. NPS 3/4 and smaller: 3/4 inch thick.
 - b. 1" NPS to 4" NPS: 1 inch thick.
 - c. Greater than 4" NPS, 1-1/2 inch thick.

3.15 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 2 inches thick.

END OF SECTION 230719

SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. The BUILDING AUTOMATION SYSTEM (BAS) Contractor shall be bound by the same Specification that the mechanical and electrical trades must follow.

1.2 SUMMARY

- A. This Section includes extent of temperature controls work for HVAC systems, subsystems, and equipment in correlation with drawings and schedules.
- B. Controls equipment and control panels to provide control sequences as outlined herein.
- C. Coordinate control work with controls provided by Equipment Manufacturers.
- D. Related Sections include the following:
 - 1. Section 23 05 03 "Submittals for HVAC".
 - 2. Section 23 09 00 "Building Automation Systems"

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and performance data for control valves, control dampers, control devices, sensors.
 - 2. Include rated capacities, operating characteristics, electrical characteristics (if applicable), and furnished specialties and accessories.
- B. Shop drawings: Submit shop drawings for each system automatically controlled, containing the following information:
 - 1. Schematic flow diagram of system showing fans, pumps, coils, boilers, chillers, dampers, valves, terminal units, and other control devices.
 - 2. Label each control device with setting or adjustable range of control.
 - 3. Indicate electric wiring; factory and field wiring.
 - 4. Indicate each control panel required, with internal and external wiring clearly indicated. Provide detail of panel face, including controls, instruments, and labeling.

C. Control Sequences:

1. Provide written sequences of operation for each controlled system and piece of equipment. Sequences shall be written in Contractor's own words and shall not be a repetition of the sequences contained herein.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer. Installer must be experienced in HVAC control system installations for not less than 5 years.
- B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Compliance: Provide electrical products which have been tested, listed and labeled by Underwriters' Laboratories (UL) and comply with NEMA standards.

1.5 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components of pneumatic control system that fail(s) in materials or workmanship within specified warranty period.
 1. Warranty Period: one year(s) from date of Substantial Completion.

1.6 GENERAL CONTROL REQUIREMENTS AND SEQUENCES

- A. BAS Contractor shall provide all 120 Volt power wiring as required for temperature control panels, damper actuators and valve actuators, and transformers as required to low voltage. BAS Contractor shall connect to existing spare at electrical panel board and provide proper circuit breaker per NEC and label panel board accordingly.
- B. This contractor shall be familiar with and responsible for wiring of all auxiliary equipment (control and power wiring), and controllers required under the mechanical division 23.
- C. These additional general requirements shall also apply.
 1. All fresh air intakes and relief/exhaust ducts or louvers, gravity roof ventilators, etc. shall have motor operated dampers. Dampers shall be low leak with blade and edge seals.
 2. All motor operated dampers shall be furnished and installed by the mechanical contractor, unless otherwise noted. All damper actuators shall be furnished and installed by the BAS Contractor, (unless damper and actuator are provided by equipment manufacturer). All damper actuators shall be wired by BAS Contractor. BAS Contractor shall provide all necessary transformers, contactors, controls and wiring for interlocking

- equipment to motor operated dampers. Provide end switches as necessary for proper sequencing of damper operation and energizing of fan motor.
3. All Programmable Thermostats shall be programmed at startup based on a time of day schedule from the owner. The owner shall be trained on the how to change the setpoints and time of day of the programmable thermostat.
 4. All control setpoints shall be graphics on the BAS computer and adjustable thru the BAS. Initial setpoints may be given in this section, but shall be adjusted in the field per actual field conditions or per the owner's recommendations. Abbreviations for the control point type are listed in the key below.
 - a. Key
 - 1) AI: Analog Input
 - 2) AO: Analog Output
 - 3) DI: Digital Input
 - 4) DO: Digital Output
 - 5) LL: Low Limit Alarm
 - 6) HL: High Limit Alarm
 - 7) GA: General Alarm

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 VARIABLE REFRIGERANT FLOW (VRF) SYSTEMS

A. Fan Coil Units

1. Startup
 - a. The unit shall operate on an occupied/unoccupied cycle as controlled from the control panel. Occupancy shall be predetermined by the owner and programmed into the control panel.
 - b. Control and monitoring points shall include but not be limited to the following:
 - 1) General Alarm
 - 2) Indoor unit on/off status
 - 3) Filter status runtime
2. Supply Fan
 - a. The supply fan shall run continuously, and modulate up and down based on a call for space heating or cooling.
 - b. Control and monitoring points shall include but not be limited to the following:
 - 1) Indoor unit mode (Ventilating)
 - 2) Supply fan on/off status
3. Space Temperature Control
 - a. Provide local wall mounted room temperature thermostat with digital display of room temperature and setpoint (+/- deg. F. adjustable) and override feature.
 - b. Control and monitoring points shall include but not be limited to the following:
 - 1) Space Temperature Setpoint

4. Minimum Outside Air Control (Coupled Ventilation)
 - a. During occupied mode the minimum outside air damper shall be open. Provide motorized outdoor air damper.
5. Cooling Control
 - a. Cooling shall be controlled to maintain space temperature setpoint. On a call for cooling the reversing valve shall move to the cooling position and modulate supply fan speed. On a further call for cooling the mechanical cooling shall be staged on.
 - b. Control and monitoring points shall include but not be limited to the following:
 - 1) Indoor unit mode (Cooling)
 - 2) Compressor on/off status
6. Heating Control
 - a. Heating shall be controlled to maintain space temperature setpoint. On a call for heating the reversing valve shall move to the heating position and modulate supply fan speed. On a further call for heating the mechanical heating shall be staged on.
 - b. Control and monitoring points shall include but not be limited to the following:
 - 1) Indoor unit mode (Heating)
7. Smoke Detector
 - a. When the smoke detector is alarmed, the system shall be alarmed and the air handler shall fail safe with manual reset. Electrical contractor shall furnish, HVAC Contractor shall mount & Electrical contractor shall wire a UL listed photoelectric smoke detector per local code authority having jurisdiction.
 - b. Fan Shutdown – Hard Wired
8. Unoccupied Mode
 - a. During the unoccupied mode of operation, the FC shall go into night setback mode.
9. Night Setback/Shutdown
 - a. Night Setback is defined by the following: The the heating is off and the mechanical cooling is off. The supply fan shall modulate in conjunction with either the heating or cooling system to maintain a night setback minimum/maximum space temperatures depending on the season.
10. Shutdown
 - a. At shutdown the FC shall go to fail safe position. Fail safe position is defined by the following: The supply fan is off, the outdoor air intake damper is closed, the heating is off and the mechanical cooling is off.

3.2 DUCTLESS SPLIT SYSTEM ACU

- A. The unit shall operate on a 7-day/night schedule with three hour occupied and/or unoccupied override. The fan shall cycle in sequence with the heating/cooling coils to maintain space temperature setpoint.

- B. Provide Low Ambient Controls on condensing unit for operation down to -20 degrees F.

3.3 CONDENSING UNITS

- A. All safeties interlocks associated with the condensing unit shall be hard wired. Software interlocks are acceptable as secondary additional safeties.
- B. Unit shall have self contained controls by unit manufacturer. Provide Low Ambient Controls on condensing unit for operation down to -20 degrees F.
- C. On a call for cooling, with all safety devices satisfied, the first stage compressor contactor and condenser fan contactor energize causing the compressor and condenser fan motor to operate (the indoor fan contactor shall be wired to start at the same time as the compressor). A liquid line solenoid valve will open when the first stage compressor starts.
- D. On a further call for cooling, the second stage compressor contactor and condenser fan contactor energize causing the second stage compressor and condenser fan motor to operate. A liquid line solenoid valve will open when the second stage compressor starts.
- E. As cooling demand decreases, the second stage compressor contactor and condenser fan contactor de-energize causing the second stage compressor and condenser fan motor to shut down. A corresponding liquid line solenoid valve will close when the second stage compressor is off preventing refrigerant migration back to the compressor during the off cycle.
- F. Control and monitoring points shall include but not be limited to the following:
 - 1. Compressors on/off status (DO/ DI)
 - 2. Condenser fans on/off status (DO/ DI)
 - 3. Outside air temperature (AI)

3.4 TERMINAL UNITS

- A. Electric Wall Heater/ Unit Heater
 - 1. Provide a self-contained integral thermostat with adjustable setpoint. On a call for heating, fan shall start and coil shall activate to maintain room temperature setpoint.

3.5 SPECIALTY CONTROLS

- A. Domestic Hot Water Return Pump
 - 1. Coordinate control work with plumbing contractor.
 - 2. Control and monitoring points shall include but not be limited to the following:
 - a. Pump on-off (DO)
 - b. Pumps Status (DI, GA)

c. Hours of operation

B. Data Closets

1. BAS Contractor shall install temperature sensor in each data closet that will alarm the BAS if temperature rises above setpoint.

C. Override Timers

1. BAS Contractor shall furnish, install and wire one 6-hour (adjustable) occupied/unoccupied override Rhodes timer located in the main office, which will activate all HVAC units.

D. Domestic Water

1. BAS Contractor shall furnish, install and wire a pulse meter with an input connection to the BAS for measuring domestic water consumption.

E. Makeup Water

1. BAS Contractor shall furnish, install and wire a flow meter in makeup water line to heat pump loop with input connection to the BAS for measuring makeup water consumption.

3.6 CONTROL WIRING

A. Low Voltage Thermostats

1. Low voltage thermostats shall be furnished, installed and wired by the HVAC contractor.
2. The electrical contractor shall provide 4" square X 1-1/2" deep wall outlet boxes (with single-gang rings) for all thermostats/sensors. The electrical contractor shall provide one 3/4" empty conduit from each thermostat/sensor location, turned out above accessible ceilings (in joist space or against overhead slab/deck).
3. The HVAC/Temperature Control Contractor shall provide all other necessary conduit, raceway and wiring related work. Conduit shall be identified in ceiling cavity and shall be provided with sweep bends, bushings and drag line.
4. The HVAC/Temperature Control Contractor shall coordinate with the General Contractor to ensure thermal envelope is maintained at these locations.

B. 120VAC BAS/Temperature Control Circuits

1. Temperature Control Contractor (TCC) shall provide all 120 Volt power wiring as required for temperature control panels and transformers to low voltage. TCC shall connect to existing spare at electrical panel board and provide proper circuit breaker per NEC and label panel board accordingly.
2. All other required 120VAC raceway and wiring related work shall be provided by the Temperature Controls Contractor.

3. The HVAC/Temperature Control Contractor shall coordinate with the General Contractor to ensure thermal envelope is maintained at these locations.

C. General Control Wiring Requirements and Installation Methods

1. Except where specifically indicated otherwise herein or within Division 23 specifications, the HVAC/Temperature Control Contractor shall provide all electrical work as required for all temperature control related wiring (i.e. conduit, raceway, outlet boxes, junction boxes, wiring, etc.) in accordance with Division 26 requirements. All conduit shall be 3/4" minimum.
2. Coordinate all thermostat/sensor locations in field (case by case) with Architect, Owner and Electrical Contractor to ensure that they are placed in locations that will not interfere with furniture, equipment, artwork, wall-hung specialties, room finishes, etc. All thermostat/sensor wall locations indicated on HVAC drawings are schematic only and must be verified case-by-case prior to rough-in.
3. All electrical work as described in this specification shall be per the latest edition of the National Electrical Code (NEC) and per applicable state and local codes. Refer to Division 26 specifications for required installation methods and follow Division 26 requirements as related to low voltage and communication technology system cables.
4. Where "free-air" installation methods (either exposed above the ceilings, in bridle rings or in cable trays) are permitted under Division 26 above ceilings, provide plenum-rated cables wherever plenum ceilings (if any) exist and install as defined under Division 26. Install low voltage circuits, located in concrete slabs and masonry walls, or exposed in occupied areas, in electrical conduit regardless of what wiring methods are permitted under Division 26.
5. Where cable trays or bridle rings are provided by the electrical contractor for low voltage cables, these raceways may be utilized for control wiring by this contractor (provide special color coded jackets, label cable jackets per Division 26 and group control wiring cables together). Provide conduit drops from cable tray/bridle ring paths to wall outlet boxes and equipment unless directed otherwise under Division 26.
6. Regardless of permitted methods in Division 26, all cables/wiring installed concealed by gypsum board, masonry or other inaccessible materials in walls or above ceilings shall be installed in conduit, 3/4" minimum.
7. All conduit, bridle rings, raceway, outlet boxes, etc. necessary for complete operational installation of control wiring shall be provided (furnished and installed) by the temperature control contractor in strict compliance with Division 26 documents. Coordinate all work with all other applicable trades including the electrical contractor.
8. Provide all required conduit work to and between equipment in a manner compliant with that described above (i.e. between VAV boxes, to boilers, starters, condensing units, etc. as applicable).
9. Install control wiring without splices between terminal points, color-coded. Where a splice is required, install within junction box. Install in neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code and per Division 26.
10. Install circuits over 25 volt with color-coded No. 12 wire in electrical metallic tubing, per Division 26. Install circuits under 25 volt with color-coded No. 18 wire with 0.031" high temperature (105 degrees F) plastic insulation on each conductor and plastic sheath over all. Install electronic circuits with color-coded No. 22 wire with 0.023" polyethylene insulation on each conductor with plastic-jacketed copper shield over all.

11. All control cabling shall be labeled at both ends with descriptive information of control device.

END OF SECTION 230993

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related sections:
 - 1. Section 23 05 03.00 "Submittals for HVAC".

1.2 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-410A:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig.
 - 2. Suction Lines for Heat-Pump Applications: 535 psig.
 - 3. Hot-Gas and Liquid Lines: 535 psig.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
 - 1. Thermostatic expansion valves.
 - 2. Solenoid valves.
 - 3. Hot-gas bypass valves.
 - 4. Filter dryers.
 - 5. Strainers.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
 - 1. Shop Drawing Scale: 1/4 inch equals 1 foot.
 - 2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between

compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.8 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88, Type K or L.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Brazing Filler Metals: AWS A5.8.
- E. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES

A. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

B. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

C. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.
8. Manual operator.

D. Thermostatic Expansion Valves: Comply with ARI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.

5. Superheat: Adjustable.
6. Reverse-flow option (for heat-pump applications).
7. End Connections: Socket, flare, or threaded union.
8. Working Pressure Rating: 450 psig.

E. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

2.3 REFRIGERANTS

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

1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.

B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

- A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
- B. Suction Lines NPS 2 to NPS 3-1/2 for Conventional Air-Conditioning Applications: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed joints.
- C. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
1. NPS 5/8 and Smaller: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
 2. NPS 3/4 to NPS 1 and Smaller: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

- A. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 - 1. Install valve so diaphragm case is warmer than bulb.
 - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 - 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- B. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- C. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.

- J. Refer to Section 23 09 00 "Building Automation Systems" and Section 23 09 93 "Sequence of Operations for HVAC Controls" for solenoid valve controllers, control wiring, and sequence of operation.
- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 08 31 13 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
- M. Install refrigerant piping in protective conduit where installed belowground.
- N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- O. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Liquid lines may be installed level.
- P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- R. Identify refrigerant piping and valves according to Section 23 05 53 "Identification for HVAC Piping and Equipment."
- S. Install sleeves for piping penetrations of walls, ceilings, and floors.
- T. Install sleeve seals for piping penetrations of concrete walls and slabs.
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors.
- V. Refrigerant piping shall be sized per equipment manufacturer's recommendations including all necessary traps, double suction risers, etc, and pipe size increases based on actual layout, distance and unit sizing.

- W. Where units are located a distance of 10 feet or more from the building exterior wall, provide PVC sleeve with full radius elbows for refrigerant piping. Piping shall be one continuous pipe with no fittings or joints where installed below grade
- X. Provide bushings between copper piping and pipe supports to eliminate dissimilar metal condition.
- Y. Where outdoor units are mounted on grade, route refrigerant piping above grade and through outside wall and up within wall for extension to indoor unit.
- Z. Bleed dry nitrogen through refrigerant piping during brazing operations.

3.4 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
- D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.
- F. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.
- H. Welded Joints: Construct joints according to AWS D10.12/D10.12M.

- I. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.5 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor products are specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

- B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

- C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.

- D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
2. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.

- E. Support multi-floor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.

- B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.

3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. During evacuation, apply heat to pockets, elbows, and low spots in piping.
4. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
5. Charge system with a new filter-dryer core in charging line per manufacturer's recommendations.

3.8 ADJUSTING

- A. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- B. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- C. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
1. Open shutoff valves in condenser water circuit.
 2. Verify that compressor oil level is correct.
 3. Open compressor suction and discharge valves.
 4. Open refrigerant valves except bypass valves that are used for other purposes.
 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- D. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 233113 - METAL DUCTS

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. Single-wall rectangular ducts and fittings.
2. Single-wall round and flat-oval ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports.

- B. Related Sections:

1. Section 23 05 03 "Submittals for HVAC".
2. Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.

1.3 PERFORMANCE REQUIREMENTS

- A. Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

- B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.

5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Ductwork Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations for selecting hangers and supports.

1.5 INFORMATIONAL SUBMITTALS

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

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. McGill AirFlow LLC.
 - b. Sheet Metal Connectors, Inc.
 - c. Dixie Sheetmetal
 - d. Eastern Sheetmetal of Cincinnati
 - e. J and I Services
 - f. Lindab
 - g. Semco Mfg., Inc.
 - h. Regional Sheetmetal Manufacturing
 - i. Tangent Air
 - j. Hranec
 - k. S.H.A.P.E. Manufacturing, Inc.
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

- D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

- E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- F. Fabricated ductwork shall comply with AMCA Standard 511 for air leakage.

2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 1. Galvanized Coating Designation: G90.
 2. Finishes for Surfaces Exposed to View: Mill phosphatized.

- C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 2. Tape Width: 3 inches.
 3. Sealant: Modified styrene acrylic.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 7. Service: Indoor and outdoor.
 8. Service Temperature: Minus 40 to plus 200 deg F.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
- C. Solvent-Based Joint and Seam Sealant:
1. Application Method: Brush on.
 2. Base: Synthetic rubber resin.
 3. Solvent: Toluene and heptane.
 4. Solids Content: Minimum 60 percent.
 5. Shore A Hardness: Minimum 60.
 6. Water resistant.
 7. Mold and mildew resistant.
 8. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
 9. Service: Indoor or outdoor.
 10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
 2. Type: S.
 3. Grade: NS.
 4. Class: 25.
 5. Use: O.
 6. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- E. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.

2.5 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- G. Trapeze and Riser Supports:
 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.

- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 DUCT SEALING

- A. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
 - 3. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
 - 4. Unconditioned Space, Exhaust Ducts: Seal Class C.
 - 5. Unconditioned Space, Return-Air Ducts: Seal Class B.
 - 6. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
 - 7. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
 - 8. Conditioned Space, Exhaust Ducts: Seal Class B.
 - 9. Conditioned Space, Return-Air Ducts: Seal Class C.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 23 33 00 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.5 PAINTING

- A. All ductwork required to be painted shall be cleaned and oil-free. Mechanical Contractor shall prepare ductwork surfaces accordingly to accept primer and paint.
- B. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer.

Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 09 91 23 "Interior Painting."

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
- C. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.
 - 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.7 DUCT CLEANING

- A. Clean new duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
 - 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 23 33 00 "Air Duct Accessories" for access panels and doors.
 - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 - 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
 - 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 - 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.8 START UP

- A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

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. Manual volume dampers.
 - 2. Motor operated dampers.
 - 3. Flange connectors.
 - 4. Turning vanes.
 - 5. Duct-mounted access doors.
 - 6. Flexible connectors.
 - 7. Flexible ducts.
 - 8. Duct accessory hardware.

- B. Related Requirements:
 - 1. Section 23 05 03 "Submittals for HVAC".

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
 - 1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Motor operated damper installations.
 - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
 - e. Duct security bars.

- f. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.6 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.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Air Balance Inc.; a division of Mestek, Inc.
 - b. American Warming and Ventilating; a division of Mestek, Inc.
 - c. Flexmaster U.S.A., Inc.
 - d. McGill AirFlow LLC.
 - e. Nailor Industries Inc.
 - f. Pottorff.
 - g. Ruskin Company.
 - h. Trox USA Inc.
 - i. Vent Products Company, Inc.
 - j. Greenheck
2. Standard leakage rating.
3. Suitable for horizontal or vertical applications.
4. For units less than 36" wide by 12" high
 - a. Frame shall be 22 gage galvanized steel.
 - b. Blade shall be single skin, 22 gage galvanized steel with center "V" groove for reinforcement.
 - c. Bearings shall be corrosion resistant synthetic sleeve type turning in an extruded hole in the damper frame.
 - d. Axles shall be 3/8" square shaft positively locked into damper blade.
5. For units over 36" wide by 12" high
 - a. Frame shall be 18 gage galvanized steel formed into a structural hat channel shape with tabbed corners for reinforcement.
 - b. Blades shall be single skin 18 gage galvanized steel with three longitudinal grooves for reinforcement.
 - c. Bearings shall be corrosion resistant synthetic sleeve type turning in an extruded hole in the damper frame.
 - d. Axles shall be hexagonal positively locked into damper blade.

B. Jackshaft:

1. Size: 1-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.

3. Include elevated platform for insulated duct mounting.

2.4 MOTOR OPERATED DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. American Warming and Ventilating; a division of Mestek, Inc.
 2. Arrow United Industries; a division of Mestek, Inc.
 3. Cesco Products; a division of Mestek, Inc.
 4. Greenheck Fan Corporation.
 5. Lloyd Industries, Inc.
 6. McGill AirFlow LLC.
 7. Metal Form Manufacturing, Inc.
 8. Nailor Industries Inc.
 9. NCA Manufacturing, Inc.
 10. Pottorff.
 11. Ruskin Company.
 12. Vent Products Company, Inc.
 13. Young Regulator Company.
- B. All louvers, gravity roof ventilators, etc. shall have motor operated dampers. Dampers shall be low leak with blade and edge seals.
- C. All motor operated dampers shall be furnished and installed by the mechanical contractor. All damper actuators shall be furnished, installed and wired by the TCC, unless damper & actuator are provided by equipment manufacturer. TCC shall provide all necessary transformers, contactors, controls and wiring for interlocking equipment to motor operated dampers. Frames shall be 4" x 1" x 0.081" minimum thickness, 6063T5 extruded aluminum hat channel with hat mounting flanges on both sides of the frame. Each corner shall be reinforced with two die formed internal braces and machine staked for maximum rigidity.
- D. All motor operated dampers integral to or utilized as part of an engineered smoke control system shall be listed and comply with UL 555S.
- E. Blades shall be airfoil type extruded aluminum, maximum 4" depth, with integral structural reinforcing tube running full length of each blade. Blade edge seals shall be extruded vinyl double edge design with inflatable pocket which enables air pressure from either direction to assist in blade to blade seal off. Blades seals shall be mechanically locked in extruded blade slots, yet shall be easily replaceable in field. Adhesive or clip-on type blade seals are not acceptable.
- F. Bearings shall be non-corrosive molded synthetic. Axles shall be hexagonal to provide positive locking connection to blades and linkage. Round axles are not acceptable. Linkage shall be concealed in frame.

- G. All dampers shall be tested in accordance with AMCA 500 and shall be rated AMCA Class 1A for 3.5 cfm/sf at 1" wg pressure for all sizes 24" wide and above.
- H. Dampers shall be parallel blade for 2-position control and opposed blade for modulating control.
- I. Provide electrical disconnect switch for all electric damper actuators.
- J. Motor operated dampers wired to emergency power shall have spring loaded normally closed actuators.

2.5 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Nexus PDQ; Division of Shilco Holdings Inc.
 - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

2.6 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Aero Dyne.
 - 2. Ductmate Industries, Inc.
 - 3. Duro Dyne Inc.
 - 4. Elgen Manufacturing.
 - 5. METALAIRE, Inc.
 - 6. SEMCO Incorporated.
 - 7. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- D. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.7 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Warming and Ventilating; a division of Mestek, Inc.
 - 2. Cesco Products; a division of Mestek, Inc.
 - 3. Ductmate Industries, Inc.
 - 4. Elgen Manufacturing.
 - 5. Flexmaster U.S.A., Inc.
 - 6. Greenheck Fan Corporation.
 - 7. McGill AirFlow LLC.
 - 8. Nailor Industries Inc.
 - 9. Pottorff.
 - 10. Ventfabrics, Inc.
 - 11. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
 - 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
 - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges Continuous and two sash locks.
 - c. Access Doors up to 24 by 48 Inches: Three hinges Continuous and two compression latches with outside and inside handles.
 - d. Access Doors Larger Than 24 by 48 Inches: Four hinges Continuous and two compression latches with outside and inside handles.
- C. Pressure Relief Access Door:
 - 1. Door and Frame Material: Galvanized sheet steel.

2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts. Factory set at 3.0- to 8.0-inch wg.
3. Doors close when pressures are within set-point range.
4. Hinge: Continuous piano.
5. Latches: Cam.
6. Seal: Neoprene or foam rubber.
7. Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.8 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Ductmate Industries, Inc.
 2. Flame Gard, Inc.
 3. Morgan Thermal Ceramics.
 4. 3M.
- B. Labeled according to UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.
- D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.
- E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
- F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.9 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Ductmate Industries, Inc.
 2. Duro Dyne Inc.
 3. Elgen Manufacturing.
 4. Ventfabrics, Inc.
 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.

- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd..
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F.

2.10 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flexmaster U.S.A., Inc.
 - 2. McGill AirFlow LLC.
 - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
 - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Temperature Range: Minus 10 to plus 160 deg F.
 - 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.
- C. Flexible Duct Connectors:
 - 1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action or Nylon strap in sizes 3 through 18 inches, to suit duct size.

2.11 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install motor operated dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel. These dampers, whether shown on the drawings or not, shall be installed at no additional cost to the Owner. Consult with Testing, Adjusting, and Balancing Agency prior to ductwork installation to establish damper locations
 - 1. Install steel dampers in steel ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire and smoke dampers according to UL listing.
- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. At outdoor-air intakes and mixed-air plenums.
 - 2. Downstream from manual volume dampers, motor operated dampers, backdraft dampers, and equipment.
 - 3. Upstream and downstream from turning vanes.
 - 4. Control devices requiring inspection.
 - 5. Elsewhere as indicated.
- I. Install access doors with swing against duct static pressure.
- J. Access Door Sizes:
 - 1. One-Hand or Inspection Access: 8 by 5 inches.

2. Two-Hand Access: 12 by 6 inches.
 3. Head and Hand Access: 18 by 10 inches.
 4. Head and Shoulders Access: 21 by 14 inches.
 5. Body Access: 25 by 14 inches.
 6. Body plus Ladder Access: 25 by 17 inches.
- K. Label access doors according to Section 23 05 53 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- L. Install flexible connectors to connect ducts to equipment.
- M. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- N. Connect flexible ducts to metal ducts with draw bands.
- O. Do not install flexible duct in inaccessible ceilings.
- P. Install duct test holes where required for testing and balancing purposes
- Q. A single length of flexible duct shall not exceed 40'.
- R. The minimum bend radius shall be 1 1/2 times the duct diameter. The radius shall be measured to the inside edge of the flexible duct.
- S. Total offset in any run of flexible duct shall not exceed 90 degrees.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 3. Inspect turning vanes for proper and secure installation.

END OF SECTION 233300

SECTION 233713 - DIFFUSERS, REGISTERS AND LOUVERS

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. Rectangular and square ceiling diffusers.
 - 2. Registers and grilles.
- B. Related Sections:
 - 1. Section 23 05 03 "Submittals for HVAC".

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 5. Duct access panels.
- B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Rectangular and Square Ceiling Diffusers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anemostat Products; a Mestek company.
 - b. Carnes.
 - c. Krueger.
 - d. METALAIRE, Inc.
 - e. Nailor Industries Inc.
 - f. Price Industries.
 - g. Titus.
 - h. Tuttle & Bailey.
 - i. Warren Technologies.
2. Material: Steel.
3. Finish: Baked enamel, white.
4. Face Size: 24 by 24 inches.
5. Face Style: Plaque.
6. Mounting: T-bar.
7. Pattern: Fixed
8. Dampers: Butterfly in drywall applications. Not required if equalizing grid is provided.

B. Registers and Grilles

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anemostat Products; a Mestek company.
 - b. Carnes.
 - c. METALAIRE, Inc.
 - d. Nailor Industries Inc.
 - e. Price Industries.
 - f. Titus.
 - g. Tuttle & Bailey.
 - h. Warren Technologies.
2. Material: Steel
3. Finish: Baked enamel, white.
4. Face Size: On Drawings
5. Mounting: Surface or T-bar.
6. Pattern: Adjustable core style.
7. Dampers: Butterfly.
8. Accessories:
 - a. Square to round neck adaptor.
 - b. Adjustable pattern vanes.

2.2 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 238126 - VARIABLE REFRIGERANT VOLUME SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 SUMMARY

- A. Provide heat recovery variable refrigerant flow systems
- B. Types of indoor system units specified in this section include the following:
 - 1. Outdoor Condensing Units
 - 2. Heat Recovery Terminal Boxes
 - 3. Indoor In-Ceiling Cassette Units
- C. Refer to Division 26 sections for the following work; not work of this section.
 - 1. Power supply wiring from power source to power connection on Air Conditioning units. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
- D. Provide the following electrical work as work of this section, complying with requirements of Division 26 sections:
 - 1. Interlock and Control wiring between field-installed controls, indicating devices, and unit control panels.
- E. Related Sections:
 - 1. Section 23 05 03 "Submittals for HVAC".

1.3 QUALITY ASSURANCE

- A. Test and rate systems in accordance with ARI 210/240.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. The units shall be listed by Electrical Laboratories (ETL) and bear the cETL label.

- D. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.
- E. The outdoor unit will be factory charged with R-410A.

1.4 INSTALLATION REQUIREMENTS

- A. The system must be installed by a factory trained contractor/dealer. The bidders shall be required to submit training certification proof with bid documents. The mechanical contractor's installation price shall be based on the systems installation requirements. Untrained contractors who wish to bid this project will have to contact their local representation to arrange training prior to bid day.

1.5 WARRANTY:

- A. Warranty on Motor/Compressor: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, motors/compressors with inadequate or defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only, and does not include labor for removal and reinstallation.
- B. Warranty Period: 5 years from date of owner acceptance

1.6 SPARE PARTS:

- A. General: Furnish to Owner, with receipt, the following spare parts for AC unit:
 - 1. 1 set filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURER:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Mitsubishi
 - 2. Daikin
 - 3. LG

2.2 OUTDOOR CONDENSING UNITS

A. General

1. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of inverter scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator. High/low pressure gas line, liquid and suction lines must be individually insulated between the outdoor and indoor units.
2. The connection ratio of indoor units to outdoor unit shall be permitted up to 130%.
3. Each outdoor system shall be able to support the connection of up to 56 indoor units dependent on the model of the outdoor unit.
4. The sound pressure level standard shall be 64 dBA or lower as measured at 3 feet from the front of the unit. The outdoor unit shall be capable of operating automatically at further reduced noise during night time.
5. The unit shall incorporate an auto-charging feature and a refrigerant charge check function. The unit shall be capable of metering the refrigerant charge. As additional refrigerant is added to the system, the system shall calculate how much additional refrigerant is required to be added to the system.
6. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation. Each system shall maintain continuous heating during oil return operation. Reverse cycle (cooling mode) oil return during heating operation shall not be permitted due to the potential reduction in space temperature.
7. Oil management:
 - a. The system shall have high pressure oil return to ensure a consistent film of oil on all moving compressor parts.
 - b. The system shall be provided with an oil separator designed to extract oil from the oil/refrigerant gas stream leaving the compressor and return the extracted oil to the compressor oil sump.
 - c. Provide an oil level sensor in the compressor to provide direct oil level sensing.
8. The outdoor unit shall be capable at the following operating ambient air conditions:
 - a. Cooling: 14°F DB to 122°F DB
 - b. Heating: -10°F DB to 61°F WB
 - c. Cooling based synchronous: 14°F DB to 81°F DB
 - d. Heating based synchronous: 14°F DB to 61°F DB
 - e. Manufacturer's that cannot provide heating operation at -10°F dry bulb shall provide supplemental electric heat or additional low ambient heating components in the condensing unit to allow for operation down to -10°F dry bulb. All additional engineering, electrical and installation costs shall be by the unit manufacturer.
9. The system shall continue to provide heat to the indoor units in heating operation while in the defrost mode. Reverse cycle (cooling mode) defrost during heating operation shall not be permitted due to the potential reduction in space temperature. Manufacturers that cannot provide heat while in defrost mode shall provide supplemental electric heat equal to the unit full load heating output. All additional engineering, electrical, and installation costs shall be by the unit manufacturer.

B. Unit Cabinet

1. Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a baked-enamel finish.
2. Unit access panels shall be removable with minimal screws and shall provide full access to the compressor, fan, and control components.
3. Outdoor compartment shall be isolated and have an acoustic lining to assure quiet operation.

C. Fans

1. Outdoor fans shall be direct-drive propeller type, and shall discharge air vertically. Fans shall discharge air through the outdoor coil.
2. The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG. A field setting switch to a maximum 0.32 in. WG pressure is available to accommodate field applied duct for indoor mounting of condensing units.
3. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
4. Fan blades shall be corrosion resistant and shall be statically and dynamically balanced.
5. Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature. Operation sound level shall be selectable from 3 steps as shown below.

6.

7. Operation Sound (dB)	Night Mode Sound Pressure Level (dB)
Step 1 max.	55
Step 2 max.	50
Step 3 max.	45

D. Compressor

1. All compressors shall be inverter driven.
2. The inverter scroll compressors shall be variable speed controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency or STD ON/OFF) shall be controlled to eliminate deviation from target value.
3. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.

4. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
5. The capacity control range shall be 4% to 100%.
6. Oil separators shall be standard with the equipment together with an intelligent oil management system
7. Compressor assembly shall be installed on spring or rubber vibration isolators and shall have internal spring isolation.
8. In the event of compressor failure for multiple compressor units, the remaining compressors shall continue to operate and provide heating or cooling as required at a proportionally reduced capacity. The microprocessor and associated controls shall be designed to specifically address this condition.
9. For multiple condenser modules, conjoined operation hours of the compressors shall be balanced by means of equalized run time, ensuring sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost or every 8 hours.

E. Outdoor Coil

1. Coil shall be constructed of aluminum fins mechanically bonded to internally enhanced, seamless copper tubes which are cleaned, dehydrated, and sealed. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance. The heat exchanger on the condensing units shall be manufactured from seamless copper tube with internal grooves mechanically bonded on to aluminum fins to an e-Pass Design. The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film. The pipe plates shall be treated with powdered polyester resin for corrosion prevention. The thickness of the coating must be between 2.0 to 3.0 microns.

F. Refrigeration Safeties

1. The following safety devices shall be included on the condensing unit;
 - a. High pressure switch.
 - b. Control circuit fuses.
 - c. Crankcase heaters.
 - d. Fusible plug.
 - e. High pressure switch.
 - f. Overload relay.
 - g. Inverter overload protector.
 - h. Thermal protectors for compressor and fan motors.
 - i. Over current protection for the inverter.
 - j. Anti-recycling timers.

G. Electrical Requirements

1. Unit electrical power shall be a single point connection.
2. Unit control voltage to the indoor-fan coil shall be 16 volt DC
3. All power and control wiring must be installed per NEC and all local building codes.
4. High and low voltage terminal block connections.
5. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one outdoor unit with one 2-cable wire.

2.3 HEAT RECOVERY TERMINAL BOXES

A. General

1. The heat recovery terminal boxes are designed specifically for use with variable refrigerant volume heat recovery system components.
2. Selector boxes shall be factory assembled, wired, and piped. Branch controllers must be run tested at the factory. Selector boxes must be mounted indoors.

B. Unit Cabinet

1. Units shall have a galvanized steel plate casing. Each cabinet shall house multiple refrigeration control valves and a liquid gas separator. The cabinet shall contain a heat exchanger shall be tube in tube type constructed from ACR copper. Cabinet insulation shall be sound absorption thermal insulation material made of flame and heat resistant foamed polyethylene. Nominal sound pressure levels shall be 44 dBA or lower as measured at 5 feet. The unit shall not require any condensate drainage connection.

C. Refrigerant Valves

1. The unit shall be furnished with 5 electronic expansion valves to control the direction of refrigerant flow. Refrigerant connections must be of the braze type.
2. The heat recovery terminal boxes can have up to six ports of independent heating/cooling operation. All ports shall be isolated with full port isolation valves.

2.4 INDOOR FAN COIL UNITS

A. IN-CEILING CASSETTE UNITS

1. General

- a. The indoor unit shall be a ceiling cassette fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, for installation into the ceiling cavity equipped with an air panel grill. It shall be a four-way air distribution type, ivory white, impact resistant, and washable decoration panel. The supply air is distributed via motorized louvers which can be horizontally and vertically adjusted from 0° to 90°. Computerized PID control shall be used to maintain room temperature within 1°F. Unit shall include a programmed drying mechanism that dehumidifies while inhibiting changes in room temperature. The indoor units sound pressure shall range from 28 dB(A) to 33 dB(A) at low speed measured at 5 feet below the unit.

2. Unit Cabinet

- a. Cabinet shall be constructed of zinc-coated steel. Fully insulated discharge and inlet grilles shall be attractively styled, high-impact polystyrene. Cabinet shall have filter tracks and cleanable filters which shall be accessible from below with a 1/4 turn fastener.
- b. Three auto-swing positions shall be available to choose, which include standard, draft prevention and ceiling stain prevention. The airflow of the unit shall have the

ability to shut down one or two sides allowing for simpler corner installation. Fresh air intake shall be possible by way of a fresh intake kit. A branch duct knockout shall exist for branch ducting supply air.

3. Fan
 - a. The fan shall be direct-drive fan with statically and dynamically balanced impeller with high and low fan speeds available. The airflow rate shall be available in high, medium, and low settings. The fan motor shall be thermally protected. Air louvers shall be adjustable for 2, 3, or 4-way discharge.
4. Coil
 - a. Coil shall be a 2-row copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. Fin spacing shall no greater than 17 fins per inch. A drip pan under the coil shall have a factory-installed condensate pump (minimum 21 inches of lift) and drain connection for hose attachment to remove condensate.
5. Motors
 - a. Motor shall be totally enclosed and permanently lubricated with inherent protection. Fan motor shall be 3-speed.
6. Controls
 - a. Controls shall consist of a solid-state electromechanical control system which shall control space temperature and determine optimum fan speed. The temperature control range shall be from 64 F to 84 F. The unit shall have the following functions as a minimum.
 - b. Provide hard wired programmable local controller and a return air sensor for each unit.
 - c. Controls shall be 24 volt, and shall be easily operated by the user from a wall-mounted control unit.
7. Operating Characteristics
 - a. The unit shall be matched with an outdoor unit. The combination of the outdoor unit and the indoor fan coil unit shall be sized as scheduled.
8. High Water Alarm
 - a. Provide sensor in cooling drain pan that will shut down the unit on high condensate levels for ceiling mounted unit.
9. Accessories (Field Installed)
 - a. Fresh Air Intake Kit
 - 1) Kit shall include filter and duct connections to provide for outdoor ventilation air.

2.5 CONTROLS

A. Physical Characteristics:

1. General: The control system shall be a neutral color plastic material. Each control may have a Liquid Crystal Display (LCD).

B. Electrical Characteristics:

1. Wiring: Wiring: Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit then to the branch selector box and outdoor unit. Control wiring shall run from the indoor unit terminal block to the specific controller for that unit. The wire shall be a non-shielded, 2-core sheathed vinyl cord or cable, size AWG18-2.

C. Controller Characteristics:

1. Local Remote Controller

- a. The Local Remote Controller shall be mounted into a standard 2" x 4" junction box.
- b. Unit Display
 - 1) The Local Remote Controller shall be approximately 4.75" x 4.75" in size with a backlit 2.75" x 1.75" LCD display. Display information shall be selectable from English, French, or Spanish.
 - 2) Provide a backlit LCD display with contrast adjustment and auto off after 30 seconds.
 - 3) The controller shall display Operation Mode, Setpoint, and Fan Speed. The controller shall display temperature setpoint in one degree increments with a range of 60-90°F. Detailed display will reflect room temperature (60-90°F range in one degree increments). Display of temperature information shall be configurable for Fahrenheit or Celsius.
 - 4) On/Off status shall be displayed with an LED.
 - 5) Error codes will be displayed in the event of system abnormality/error with a two digit code.
 - 6) The following system temperatures can be displayed to assist service personnel in troubleshooting:
 - a) Return air temperature
 - b) Liquid line temperature
 - c) Gas line temperature
 - d) Discharge air temperature (if available on the unit)
 - e) Remote temperature sensor temperature
 - f) Indoor temperature setpoint

2. Operation

- a. The unit shall be capable of controlling a group of up to 16 indoor units. The following operation groups shall be controlled:
 - 1) On/Off, Operation Mode (Cool, Heat, Fan, Dry and Auto* (*with VRV Heat Recovery System))
 - 2) Independent cooling and heating setpoints in the occupied mode
 - 3) Independent cooling setup and heating setback
 - 4) Fan speed
 - 5) Airflow direction
 - 6) The controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating in the occupied period

- 7) Lock out key settings
 - 8) Indoor unit group assignment
3. Program Functions
- a. Controller shall support schedule settings with selectable weekly pattern options.
 - 1) Seven day week
 - 2) Weekday + weekend
 - 3) Weekday + Saturday + Sunday
 - 4) Independently settable cooling and/or heating setpoints when unit is on (occupied).
 - 5) Setup cooling and heating setback setpoints when unit is off (unoccupied)
 - 6) A maximum of 5 operations can be schedulable per day
 - 7) Time setting in 1-minute increments
 - b. The Controller shall support auto-changeover mode for both heat pump and heat recovery systems allowing the optimal room temperature to be maintained by automatically switching the indoor unit's mode between Cool and Heat according to the room temperature and temperature setpoint.
 - 1) Changeover to cooling mode shall occur at cooling setpoint + 1°F.
 - 2) Changeover to heating mode shall occur at heating setpoint - 1°F.
 - c. The Controller shall support an Auto-Off-Timer for temporarily enabling indoor unit operation during the unoccupied period.
 - 1) When the Off Timer is enabled and when the unit is manually turned on at the remote controller, the controller shall shut off the unit after a set time period.
 - 2) The time period shall be configurable in the controller menu with a range of 30-180 minutes in 10 minute increments.
 - d. The space temperature shall be capable of being sensed at the local controller, the return air temperature sensor mounted in the unit, or a remote temperature sensor.

D. Multi-Zone Controller – Centralized Remote

1. General
 - a. The centralized remote controller shall provide control for all indoor units. It shall be capable of controlling a maximum of 64 indoor unit groups and 128 indoor units connected to a maximum of 10 outdoor units. The centralized remote controller shall support operations superseding that of the local remote controller, system configuration, daily/weekly scheduling, monitoring of operation status, and malfunction monitoring.
 - b. The controller wiring shall consist of a non-polar two-wire connection to the indoor unit at terminals of the outdoor unit. The centralized remote controller is wall mounted and can be adjusted to maintain the optimal operation of the connected indoor unit(s).
 - c. The centralized remote controller can be used in conjunction with BACnet, and Lonworks interfaces to control the same indoor unit groups. No more than 2 remote controllers can be placed in the same group. The remote controller shall require daisy chain wiring for grouping multiple indoor units (up to 16) together. Manual addressing is required of each indoor unit group associated with the centralized remote controller.

- d. The centralized remote controller shall be equipped with one RJ-45 Ethernet port to support interconnection with a network PC via the internet or Local Area Network (LAN).
 - e. Optional software functions shall be available so that facility staff can securely log into each centralized remote controller via the PC's web browser to support monitoring, scheduling, error email, and general user functions. Additional optional software functions of Tenant Billing, and HTTP Interface shall also be available. The optional software shall require advanced purchase and can only be activated upon receipt of a license key from the manufacturer.
2. Mounting
- a. The centralized remote controller shall be mounted on the wall or into a recessed fixing box.
3. Display Features
- a. The centralized remote controller shall be approximately a 10" LCD display. Display information shall be selectable from English, French, Italian, German, or Spanish.
 - b. Featured backlit LCD with contrast adjustment and auto off after 30 minutes (default) is adjustable between 1 to 60 minutes.
 - c. Area and Group configuration
 - 1) Area contains one (1) or more Area(s) or Group(s)
 - 2) A Group may be an indoor unit, DI, DO point that has a network address.
 - d. An Area is a tiered group where management points (indoor unit, digital input/output and analog input groups) can be monitored and controlled by global settings. Up to 650 Areas can be created. Area hierarchy can have up to 10 tiered levels. Area configuration shall classify levels of monitoring and control for each management point.
 - e. The Controller shall display Date (mm/dd/yyyy or dd/mm/yyyy format selectable) and day of the week along with the time of day (12hr or 24hr display selectable).
 - f. The Controller shall adjust for daylight savings time (DST) automatically.
 - g. Display information shall be updated every 3 seconds to show the latest status of the indoor unit groups.
 - h. System status icons shall display On/Off (color coded), Malfunction/Error (color coded), Forced Stop, Set Schedule/Setback/Auto-changeover, Filter, and Screen Lock.
 - i. The controller shall display the temperature setpoint in one degree increments with a range of 60⁰F - 90⁰F. Display of temperature setpoint information shall be configurable for Fahrenheit or Celsius.
 - j. Display shall reflect room temperature 0⁰F - 176⁰F range in one degree increment.
 - 1) Display of room temperature information shall be configurable for Fahrenheit or Celsius.
 - k. The system setting mode shall be used to configure options and display information for each Zone or Group.
 - l. Zone configuration shall display Setpoint Range Limitation, Setback Temperature setting, and Auto-changeover for each Zone.
 - m. Floor plan layout: Capable of displaying site floor plan as the background for visual navigation. Indoor unit, DIII-NET DI and DO, and External DI, DO, and AI icons with operational status can be placed on the floor layout. Up to 4 status points can be assigned to the indoor unit icon (room name, room temperature,

- setpoint, and mode). Digital input and output icons will display On/Off status. Analog input icons will display analog value. The system shall have the ability to create up to 60 floor layout sections.
- n. Indoor units shall be capable of being displayed by Zone or Group.
 - 1) Zones configuration via the centralized remote controller shall consist of a single indoor unit group or a collection of indoor unit groups blocked together for control and monitoring purposes.
 - 2) Groups shall consist of 1 to 16 indoor units daisy chained together via the remote control wiring to the indoor unit terminal block for control and monitoring purposes.
 - 3) Groups and Zones may be assigned names (ex. Office 101, Lobby, North Hallway, etc...)
 - o. Error status shall be displayed in the event of system abnormality/error with one of three color coded icons placed over the indoor unit icon.
 - 1) System errors are generated when the centralized remote control system with other VRV controls systems combined or power proportional distribution calculation errors occur. The centralized remote control system shall display the error with a red triangle placed on the lower task bar. Unit errors occurring within the VRV system shall be displayed with a yellow triangle placed over the indoor unit icon. Limit errors are based upon preconfigured analog input upper and lower limit settings and are generated when the limits have been met. When limit error is generated a yellow triangle will be placed over the unit icon. Communication errors between the centralized remote control system and the indoor units shall be displayed with a blue triangle placed over the indoor unit icon. Error history shall be available for viewing for up to 500,000 errors/abnormality event.
4. Basic Operation:
- a. Capable of controlling Zone(s) or Group(s) of up to 64 indoor unit groups (128 indoor units).
 - b. Controller shall control the following group operations.
 - 1) On/Off
 - 2) Operation Mode (Cool, Heat, Fan, Dry, and Auto)
 - 3) Independent Cooling and Heating setpoints in the occupied mode
 - a) Cooling setpoint shall be maintained higher than or equal to the heating setpoint
 - b) Adjustable minimum setpoint differential 0 - 7⁰F between cooling and heating setpoint
 - c) Selectable single setpoint mode
 - 4) Independent Setup (Cooling) and Setback (Heating) setpoints in the unoccupied mode adjustable to 40 - 95⁰F.
 - a) Setup and Setback setpoints shall be set outside of the occupied setpoint range.
 - b) The recovery differential shall be 4⁰F (default) and adjustable between 2 – 10⁰F.
 - c) Settings shall be applied based upon the Zone configurations.
 - 5) Fan Speed
 - a) Up to 3 speeds (dependent upon indoor unit type).
 - 6) Airflow direction

- a) 5 fixed positions or swing position.
 - 7) The controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating based upon the Zone configurations.
 - 8) Remote controller permit/prohibit of On/Off, Mode, and Setpoint.
 - c. Capable of providing battery backup power for up to 2 years in total time for the clock. All settings shall be stored in non-volatile memory.
5. Programmability
- a. Controller shall support weekly schedule settings.
 - 1) Selectable weekly patterns
 - a) 7-day
 - b) Weekday + weekend
 - c) Weekday + Saturday + Sunday
 - 2) The schedule shall support unit On/Off.
 - 3) 100 independent schedules configurable with up to 20 events settable for each schedule.
 - a) Each scheduled event shall specify time and target Zone or Group
 - b) Each scheduled event shall include On/Off, Operation Mode, Occupied Cooling Setpoint, Occupied Heating Setpoint, Setup (Cooling) Setpoint, Setback (Heating) Setpoint, Remote Controller On/Off Prohibit, Remote Controller Mode Prohibit, Remote Controller Setpoint Prohibit, and Timed Override Enable.
 - c) Independently settable Cooling and Heating setpoints when unit is on (occupied).
 - d) Setup (Cooling) and Setback (Heating) setpoints when unit is off (unoccupied) by Zone.
 - e) Time setting in 1-minute increments.
 - f) A 2 hour override shall be provided for use enabling indoor unit operation during the unoccupied period.
 - 4) A maximum of 40 exception days can be schedule on the yearly schedule.
 - a) Exception days shall be used to override specified days on the weekly schedule based upon irregular occupied/unoccupied conditions.
 - b) Exception days can be configured on a set date (Jan 1) or floating date (1st Monday in September).
 - b. The controller shall support auto-changeover
 - 1) Auto-change shall provide Individual, Fixed, and Averaging changeover methods for both Heat Pump and Heat Recovery systems based upon the Zone configurations. This will allow for the optimal room temperature to be maintained by automatically switching the indoor unit's mode between Cool and Heat in accordance with the room temperature and setpoint temperature.
 - 2) Individual method (recommended for Heat Recovery Systems)
 - a) Changeover evaluated by room temperature and setpoints of the individual indoor unit group in the Zone.
 - b) Changeover affects individual indoor unit group in the Zone.
 - 3) Fixed method
 - a) Changeover evaluated by room temperature and setpoints of the representative unit (first registered unit) in the Zone.
 - b) Changeover affects all indoor unit groups in the Zone.
 - 4) Average method

- a) Changeover evaluated by the average of all indoor unit group's room temperatures and setpoints in the Zone.
 - b) Changeover affects all indoor unit groups in the Zone.
 - 5) Changeover shall change the operation mode of the indoor unit that is set as the Changeover Master. The Changeover Master indoor unit shall then change the operation mode of all indoor unit groups daisy chained to the same outdoor unit in the Heat Pump system or branch selector box in the Heat Recovery system.
 - 6) Changeover to cooling mode shall occur when the room temperature is greater than or equal to the cooling setpoint, and the room temperature is greater than or equal to the average of the cooling and heating setpoints + 2.7°F.
 - 7) Changeover to heating mode shall occur when room temperature is less than or equal to the heating setpoint, and the room temperature is less than or equal to the average of the cooling and heating setpoints - 2.7°F.
 - 8) One hour guard timer
 - a) Upon changeover, guard timer will prevent another changeover during this period.
 - b) Guard timer is ignored by a change of setpoint manually from either centralized remote controller, local remote controller or by schedule.
 - c) 60 minutes as default, configurable to 15, 30, or 90 minutes.
 - 9) Third party devices
 - a) Interlock feature for use with 3rd party equipment (DOAS, dampers, occupancy sensing, etc...) to automatically control groups or zones corresponding to the change of the operation states or the On/Off states of any group.
 - b) Requires digital input/output unit.
 - c) On/Off based monitoring and control of equipment.
 - d) Manual or scheduled operation of equipment.
 - e) Operation based upon interlock with VRV indoor unit group(s).
 - f) Monitor equipment error/alarm status.
 - 10) Controller shall support force shutdown of associated indoor unit groups.
6. Software
- a. Licensed per option, per centralized remote controller shall be required. All PCs shall be field supplied.
 - 1) Web/Email software
 - a) Each centralized remote controller shall be capable of monitoring, operating, and scheduling a maximum of 64 indoor unit groups (128 indoor unit groups with the addition of an expansion module) from a networked PC's web browser. It shall also be capable of creating general user access and sending detailed error emails to a customized distribution list (up to 3 email addresses).
 - 2) Power Proportional Distribution (PPD)
 - a) The tenant billing option shall be capable of calculating VRV Controls Network equipment energy usage in kWh based on the energy consumption of the outdoor unit(s) divided among the associated indoor units. This software is used in conjunction with the centralized remote controller and a Watt Hour Meter (WHM). A maximum of 3 Watt Hour Meters can be connected to the centralized remote controller.

- b) The Power Proportional Distribution results data can be saved to a PCMCIA card, or on a PC with the use of the web option software. Data is saved in the CSV format. Results can be stored up to 12 months.
- 3) HTTP Interface
 - a) This option shall be capable of creating a software interface between the VRV Controls Network and Home Automation control systems.

E. BAS GATEWAY- BACnet or LonTalk

1. General

- a. The Interface for use in BACnet or LonTalk shall provide the gateway for a Building Automation System (BAS) to perform all controlling functions related to the spaces served by all indoor and outdoor units. It shall be capable of controlling a maximum of 4 complete systems of 64 indoor unit groups (128 indoor units) connected to a maximum of 10 outdoor units on each system. Each system is independent of each other and each system will terminate on its own ports.
- b. The Interface shall allow the BAS to supersede all of the controlling functions of the local centralized controller, local remote controller, system configuration, daily/weekly scheduling, monitoring of operation status, and malfunction monitoring. All controlling parameters and logic shall reside in the BAS and shall be accomplished through programming at the BAS front end controllers.
- c. The Interface for use in BACnet uses a standard open protocol based on ANSI/ASHREA Standard 135. The BACnet Interface has been certified by the BACnet Testing Laboratories (BTL). The BACnet Interface is compatible with BACnet IP (ISO16484-5). Interfaces that have not been certified by the BACnet Testing Laboratories shall not be acceptable.
- d. The interface wiring shall consist of a non-polar two-wire connection to the terminals of the outdoor unit. The Interface shall be wall mounted and is used as a translator between the Building Automation System (BAS) and the VRF communication bus to maintain and control the operation of the connected indoor unit(s).
- e. The Interface shall be equipped with one RJ-45 Ethernet port to support interconnection with a network PC via the Internet or Local Area Network (LAN). The Ethernet connection shall be capable of transmission on 10Base-T and/or 100Base-TX connection at 100 Mbps.
- f. The Interface shall be capable of being configured as a foreign device. It shall be capable of communicating across LonMark certified or BACnet Broadcast Management Devices (BBMD) in different subnet networks.
- g. The Interface shall be capable of supporting Change of Value (COV) notification for all available objects.
- h. A setup tool shall be available so that certified commissioning personnel/facility staff can securely log into each Interface via a PC to support the configuration and testing of the Interface.

2. Mounting

- a. The Interface shall be mounted on the wall or in an enclosure.

3. Display Features

- a. LED display provides the interface's operational status and alarm.
 - b. The Interface shall be capable of displaying indoor unit objects on the BACnet building management system. It shall provide the building management system the capability to command the setpoint temperature in 1⁰F (0.1⁰C) increments with a range of 60⁰F - 90⁰F. Display of temperature setpoint information shall be configurable for Fahrenheit or Celsius.
 - c. The Interface shall provide the BACnet building management system the capability to display the room temperature in 0.1⁰F increments with a range of - 120⁰F - 180⁰F. Display of room temperature information shall be configurable for Fahrenheit or Celsius.
 - d. Error codes generated by the indoor units, outdoor units, heat recovery boxes, and remote controllers shall be displayed on the building management system in the event of system abnormality/error. Communication errors between the Interface and the building management system shall be displayed.
4. Basic Operation
- a. The Interface will provide up to 28 objects that can be monitored/controlled via the building management system. It shall be capable of controlling up to 64 indoor unit groups (128 indoor units) per port. Expansion modules can be added to increase the number of ports to a total of 4 ports.
 - b. The Building Management System shall directly control the following group operations:
 - 1) On/Off
 - 2) Operation Mode (Cool, Heat, Fan, Auto, and Dry)
 - 3) Single setpoint setting for Cooling and Heating in the occupied mode
 - 4) Fan status
 - 5) Fan Speed
 - a) Up to 3 speeds (dependent upon indoor unit type)
 - 6) Vane directions
 - 7) Remote controller permit/prohibit of On/Off, Mode, and Setpoint
 - 8) Filter sign reset for indoor units
 - 9) Disable the central controller
 - 10) Forced off of indoor units
 - 11) Energy saving offset of indoor unit setpoint
 - 12) Compressor status
 - 13) Heater status
 - c. The interface shall be capable of providing battery backup power for up to 3 years in total time for the clock. Settings shall be stored in non-volatile memory.
5. Programmability
- a. The building management system is responsible for all weekly schedule settings through its programming and code.
 - 1) The schedule shall fully control all functions of the indoor unit as listed in the following:
 - a) On/Off
 - b) Each scheduled event shall specify time and target group.
 - c) Each scheduled event shall include On/Off, Operation Mode, Occupied Cooling Setpoint, Occupied Heating Setpoint, Setup (Cooling) setback setpoint, Setback (Heating) setback setpoint, Remote Controller On/Off Permit/Prohibit, Remote Controller Mode

- Permit/Prohibit, Remote Controller Setpoint Permit/Prohibit, and Timed Override Enable.
- d) Setup (Cooling) and Setback (Heating) setpoints when unit is off (unoccupied) by Group.
 - e) An override shall be provided for use enabling indoor unit operation during the unoccupied period by the building management system programming.
- 2) The building management system shall perform the auto-changeover through its programming.
- a) Auto-change shall provide changeover for both Heat Pump and Heat Recovery systems based upon the group configurations. This will allow for the optimal room temperature to be maintained by BAS for automatically switching the indoor unit's mode between Cool and Heat in accordance with the room temperature and setpoint temperature.
 - b) Changeover shall change the operation mode of the indoor unit that is set as the Changeover Master. The Changeover Master indoor unit shall then change the operation mode of all indoor unit groups daisy chained on the same communication bus to the same outdoor unit in the Heat Pump system or the same heat recovery box in the Heat Recovery system.
 - c) Changeover to cooling mode shall occur when the room temperature is great than or equal to the cooling setpoint.
 - d) Differential is determined and set by the building management system programming.
 - e) Changeover to heating mode shall occur when room temperature is less than or equal to the heating setpoint. Differential shall be controlled by the building management system programming.
 - f) The Guard Timer- Upon changeover, the guard timer will prevent another changeover during this period. The Guard timer should be ignored by a change of setpoint manually from the BAS, centralized controller, local remote controller, or by schedule. The guard timer shall be controlled and configured by building management system programming (30 minute minimum recommended).
- 3) The Interface shall allow the BAS to force a shutdown of associated indoor unit groups.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which air conditioning units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION:

- A. General: Install units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Support: Install exterior units on grade on 4" thick concrete pad.
- C. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
- D. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.
- E. Drain Piping: Connect unit drain to nearest indirect waste connection. Provide trap at drain pan; construct at least 1" deeper than fan pressure in inches of water.

3.3 START UP AND COMMISSIONING

- A. The unit manufacturer will be responsible for the start-up, programming, and commissioning of the entire variable refrigerant volume system. This will include coordinating the interface requirements and system points with the temperature controls contractor. Manufacturer shall test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

3.4 TRAINING OF OWNER'S PERSONNEL:

- A. Provide services of manufacturer's technical representative for 1day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 day notice to Contractor and Engineer of training date.

END OF SECTION 238126

SECTION 238129 - DUCTLESS SPLIT SYSTEM AIR CONDITIONING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 SUMMARY

- A. Types of ductless split system units specified in this section include the following:
 - 1. Outdoor Condensing Units
 - 2. Indoor High Wall Units
- B. Refer to Division 26 sections for the following work; not work of this section.
 - 1. Power supply wiring from power source to power connection on Air Conditioning units. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
- C. Provide the following electrical work as work of this section, complying with requirements of Division 26 sections:
 - 1. Interlock and Control wiring between field-installed controls, indicating devices, and unit control panels.
- D. Related Sections:
 - 1. Section 23 05 03 "Submittals for HVAC".

1.3 QUALITY ASSURANCE

- A. Test and rate systems in accordance with ARI 210/240.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.4 WARRANTY:

- A. Warranty on Motor/Compressor: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, motors/compressors with inadequate or defective

materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only, and does not include labor for removal and reinstallation.

- B. Warranty Period: 5 years from date of owner acceptance

1.5 SPARE PARTS:

- A. General: Furnish to Owner, with receipt, the following spare parts for AC unit:

1. 1 set filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURER:

- A. Subject to compliance with requirements, provide ductless split system air conditioning units of one of the following manufacturers:

1. Mitsubishi
2. LG
3. Daikin

2.2 OUTDOOR CONDENSING UNITS

- A. General

1. Factory assembled, single piece, air-cooled outdoor unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, compressor, full charge of HFC refrigerant, and special features required prior to field start-up.

- B. Unit Cabinet

1. Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a baked-enamel finish.
2. Unit access panels shall be removable with minimal screws and shall provide full access to the compressor, fan, and control components.
3. Outdoor compartment shall be isolated and have an acoustic lining to assure quiet operation.

- C. Fans

1. Outdoor fans shall be direct-drive propeller type, and shall discharge air horizontally. Fans shall blow air through the outdoor coil.

2. Outdoor fan motors shall be totally-enclosed, single-phase motors with Class B insulation and permanently-lubricated sleeve bearings. Motor shall be protected by internal thermal overload protection.
3. Shaft shall have inherent corrosion resistance.
4. Fan blades shall be corrosion resistant and shall be statically and dynamically balanced.
5. Outdoor fan openings shall be equipped with PVC coated protection grille over fan and coil.

D. Compressor

1. Compressor shall be fully hermetic reciprocating or scroll type.
2. Compressor shall be equipped with oil system, operating oil charge, and motor. Internal overloads shall protect the compressor from overtemperature and overcurrent. Scroll compressors shall also have high discharge gas temperature protection if required.
3. Motor shall be NEMA rated Class F, suitable for operation in a refrigerant atmosphere.
4. Reciprocating compressors shall be equipped with crankcase heaters to minimize liquid refrigerant accumulation in compressor during shutdown and to prevent refrigerant dilution of oil.
5. Compressor assembly shall be installed on rubber vibration isolators and shall have internal spring isolation.
6. Compressors shall be single-phase or 3-phase as specified on the contract drawings.

E. Outdoor Coil

1. Coil shall be constructed of aluminum fins mechanically bonded to internally enhanced, seamless copper tubes which are cleaned, dehydrated, and sealed.

F. Refrigeration Components

1. Refrigerant circuit components shall include brass external liquid line service valve with service gage port connections, suction line service valve with service gage connection port, service gage port connections on compressor suction and discharge lines with Schrader-type fittings with brass caps, accumulator, pressure relief, and a full charge of refrigerant.

G. Controls and Safeties

1. Operating controls and safeties shall be factory selected, assembled, and tested. The minimum control functions shall include the following:

H. Controls

1. Time delay restart to prevent compressor reverse rotation on signal-phase scroll compressors.
2. Automatic restart on power failure.
3. Safety lockout if any outdoor unit safety is open.
4. A time delay control sequence provided through the fan coil board, thermostat, or controller.

5. High-pressure and liquid line low-pressure switches.
6. Automatic outdoor fan motor protection.
7. Start capacitor and relay (single phase units without scroll compressors).

I. Safeties

1. System diagnostics.
2. Compressor motor current and temperature overload protection
3. High pressure relief.
4. Outdoor fan failure protection.

J. Electrical Requirements

1. Unit electrical power shall be a single point connection.
2. Unit control voltage to the indoor-fan coil shall be 24 volt
3. All power and control wiring must be installed per NEC and all local building codes.
4. High and low voltage terminal block connections.

K. Special Features (Field Installed)

1. Low-Ambient Kit
 - a. Control shall regulate fan-motor cycles in response to saturated condensing pressure of the unit. The control shall be capable of maintaining a condensing temperature of 100 F +/- 10 F with outdoor temperatures to -20F. Installation of kit shall not require changing the outdoor-fan motor.
2. Winter Start Control
 - a. Field supplied and installed winter start control shall permit start-up for cooling operation under low-load conditions and at low-ambient temperatures by bypassing the low-pressure switch for a 3-minute delay period.
3. Crankcase Heater (units with scroll compressors only).
 - a. Unit shall be shipped with a clamp-on compressor oil sump heater.

2.3 HIGH WALL UNITS

A. General

1. Indoor, direct-expansion, wall-mounted fan coil. Unit shall be complete with cooling/heating (heat pump systems only) coil, fan, fan motor, piping connectors, electrical controls, microprocessor control system, and integral temperature sensing. Unit shall be furnished with integral wall-mounting bracket and mounting hardware.

B. Unit Cabinet

1. Cabinet discharge and inlet grilles shall be attractively styled, high-impact polystyrene. Cabinet shall be fully insulated for improved thermal and acoustic performance.

C. Fans

1. Fan shall be tangential direct-drive blower type with air intake at the upper front face of the unit and discharge at the bottom front. Automatic, motor-driven vertical air sweep shall be provided standard.
2. Air sweep operation shall be user selectable. Horizontal direction may be manually adjusted (using remote controller) and vertical air sweep may be manually set.

D. Coil

1. Coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate. Condensate pan shall have internal trap and auxiliary drip pan under coil header.
2. Condensate Pan: Provide IAQ galvanized steel, double sloping drain pan. Provide high condensate in primary condensate pan to de-energize unit upon detection of high condensate levels.

E. Motors

1. Motors shall be open drip-proof, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be 3-speed.

F. Controls

1. Controls shall consist of a microprocessor-based control system, which shall control space temperature, determine optimum fan speed, and run self diagnostics. The temperature control range shall be from 64F to 84F. The unit shall have the following functions as a minimum.
 - a. Provide hard wired wall thermostat secured to wall. (remote control stats are not acceptable).
 - b. An automatic restart after power failure at the same operating conditions as at failure.
 - c. A timer function to provide a minimum 24-hour timer cycle for system Auto. Start/Stop.
 - d. Temperature-sensing controls shall sense return air temperature. Indoor air high discharge temperature shutdown shall be provided.
 - e. Indoor coil freeze protection.
 - f. Wireless infrared remote control to enter set points and operating conditions.
 - g. Auto Stop features shall have integral setback control.
 - h. Automatic airsweep control to provide on or off activation of airsweep louvers.
 - i. Dehumidification mode shall provide increased latent removal capability by modulating fan speed and set point temperature.
 - j. Fan only operation shall provide room air circulation when no cooling is required.
 - k. Diagnostics shall provide continuous checks of unit operation and warn of possible malfunctions. Error messages shall be displayed at the unit and at the remote controller.
 - l. Fan speed control shall be user-selectable: high, medium, low or microprocessor automatic operation during all operating modes.

- m. A time delay shall prevent compressor restart in less than 3 minutes.

G. Filters

1. Unit shall have filter track with factory-supplied cleanable filters.

H. Electrical Requirements

1. Unit shall operate on 115 volt, 208 volt, or 230 volt, 60 Hz power supply as specified on the equipment schedule. Power and control connections shall have terminal block connections.

I. Operating Characteristics

1. The unit shall be matched with an outdoor unit. The combination of the outdoor unit and the indoor fan coil unit shall be sized as scheduled
2. The system shall have a minimum listed SEER (seasonal energy efficiency ratio) of 10.0 at ARI conditions.
3. Outdoor unit shall be rated at low decibels at ARI conditions.

J. Refrigerant Lines

1. The 009 and 012 units shall have rotatable refrigerant lines for penetration through the wall using flare connections. All units shall have flare connections and a 90-degree suction elbow shall be provided for rear connection.

K. Special Features (Field Installed)

1. Condensate Pump
 - a. The condensate pump shall remove condensate from the drain pan when gravity drainage cannot be used. Pump shall be designed for quiet operation. Pump shall consist of two parts: an internal reservoir/sensor assembly, and a remote sound-shielded pump assembly. The lift capability of the condensate pump shall be 1 to 10 ft (3/4 ton unit) or 3 to 25 ft (1-2 ton units). A level sensor on the condensate pan shall stop cooling operation if the level in the condensate pan is unacceptable.
2. Electronic Programmable Thermostat
 - a. Provide hard-wired wall thermostat secured to wall. (remote control stats are not acceptable).
 - b. Thermostat shall be commercial grade and shall provide 7-day, 4-event scheduling. Integral subbase shall be included. Thermostat shall also provide 3-speed fan switchover capability, air sweep auto changeover, and shall not require a battery to retain memory.

PART 3 - EXECUTION

3.1 INSPECTION:

- A. Examine areas and conditions under which air conditioning units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF DUCTLESS SPLIT SYSTEM UNITS:

- A. General: Install units in accordance with manufacturers installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Support: Install exterior units on grade on 4" thick concrete pad.
- C. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
- D. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.
- E. Drain Piping: Connect unit drain to nearest indirect waste connection. Provide trap at drain pan; construct at least 1" deeper than fan pressure in inches of water.
- F. Start-up AC units, in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

3.3 TRAINING OF OWNER'S PERSONNEL:

- A. Provide services of manufacturer's technical representative for 1-half day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7-day notice to Contractor and Engineer of training date.

END OF SECTION 238129

SECTION 260501 - COMMON REQUIREMENTS FOR ELECTRIC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplemental Conditions and Division-1 Specification sections, apply to work of Division 26 sections.
- B. E-series drawings apply to work of Division 26 sections and vice versa.

1.2 SPECIAL CONDITIONS

- A. Owner's representative or engineer may relocate luminaire(s), wiring device(s) or equipment outlet(s) prior to installation within a 15 foot limit at no additional charge.
- B. Complete work, or part(s) thereof, at such time as may be designated by the owner's representative, so that it can be used for temporary or permanent use. Do not construe such use of the system as an acceptance of same by Owner.
- C. Review load summaries of power distribution equipment prior to rough-in or installing conductors, and after coordinating with suppliers and other trades, including relevant submittals. Bring abnormal conditions to the attention of the design professional, such as significant load conditions, and unusual phase imbalances.

1.3 GENERAL STANDARDS

- A. Provide work in compliance with applicable provisions of the following standards. Provide UL listing and UL label for electrical materials, equipment luminaires, devices, etc.
- B. Provide work in strict accordance with the latest edition of applicable codes including (but not limited to) the following codes and standards.
 - 1. National Electrical Code (NEC), NFPA 70
 - 2. Life Safety Code, NFPA 101
 - 3. Other Provisions of NFPA as applicable
 - 4. Local Electrical Codes
 - 5. Local utility company requirements
 - 6. ADA/ADAAG requirements
 - 7. ASME
 - 8. International Building Code
 - 9. IECC 2009
 - 10. Kentucky Building Code

1.4 PERMITS AND REGULATIONS

- A. Provide written notification to Engineer's office with list of inspection agency choices if multiple electrical plan review or inspection agencies are permitted in the jurisdiction of the project. The final agency selection belongs to the Engineer.
- B. Provide electrical materials, installation methods, workmanship, testing, etc., unless otherwise specified, that conforms with the latest rules, regulations and specifications of the National Electrical Code, the National Board of Fire Underwriters, local and state codes having jurisdiction and applicable utility companies.
- C. If a discrepancy between Division 26 drawings and specifications, and codes, laws, ordinances, rules and regulations is discovered, immediately notify the engineer and proceed no further with related work until response is received.
- D. Obtain and pay for permits, certificates of inspection and approval, etc. required for this branch of the work.
- E. Furnish owner with certificates of final inspection and approval prior to final acceptance of this branch of the work.

1.5 SPECIFICATIONS AND TERMINOLOGY

- A. Unless otherwise indicated in specifications or on drawings, wherever the term "furnish" appears in documents, interpret to mean "supply and deliver to project site, ready for installation, and install". See definition of "install" in paragraph below.
- B. Wherever the term "install" appears in documents, or is intrinsically included as part of "furnish" and/or "provide" in paragraphs above and below, interpret to mean "Assemble, wire and connect loose-shipped components on site. Place in position for service or use, including material, labor, accessories, services, and testing. Wire, connect, and render fully operational for intended use ". Note that most products to be installed shall also be furnished under Division 26, though some products require only installation under Division 26 - depending on context and application.
- C. Wherever the terms "provide", "include", "shall be", "to be", "equip with", "consisting of", or similar terms appear in documents, interpret to mean "Furnish and Install".
- D. Wherever the word "work" appears in documents, interpret to mean "material, labor, accessories, services, testing, etc. as required to render respective work fully operational".
- E. Wherever the words "equal" or "equivalent" or similar terms are used in documents in reference to products other than basis-of-design, equivalency shall be as determined by Design Professional.

- F. Wherever the word “flush” appears, interpret to mean “recessed in respective surface with visible face flush and even with respective surface”.
- G. Wherever the words "(the) (this) contractor", "(the) (this) subcontractor", "E.C./EC", “electrical contractor”, “electrical subcontractor” or similar terms appear in Division 26 specifications or on electrical drawings, they refer the entity responsible for providing electrical work indicated on electrical drawings, and in Division 26 Project Manual sections.

1.6 EXPLANATION AND PRECEDENCE OF DRAWINGS

- A. For the purposes of clearness and legibility, drawings are essentially diagrammatic and although size and locations of equipment are drawn to scale wherever possible, make use of data on drawings and verify information at building site.
- B. The drawings indicate required size and points of termination of conduit and partially suggest proper routes to conform to the structure, avoid obstructions and preserve clearances. However, it is not intended that drawings indicate necessary offsets. Install conduit and equipment in such manner as to conform to structure, avoid obstructions, preserve headroom and keep openings and passageways clear without further instructions.
- C. Coordinate work with affected entities and installers. Locate and install equipment and devices accordingly. Refer to coordination drawings of other trades.
- D. Locate apparatus be located symmetrical with architectural elements and install at exact height and locations as shown on architectural drawings.
- E. Fully research peculiarities and limitations of space available for installation of work along with materials to be furnished and installed. Exercise due and particular caution to ensure that parts of the installed work are made quickly and easily accessible. Although the locations of the equipment and conduit may be shown on the drawings in certain positions, be guided by the architectural details and conditions existing at the job site, correlating electrical work with that of others. Provide offsets as required to provide a neat workmanlike arrangement.
- F. Where connecting lines are shown outside the confines of a building, serving indoor or exterior wall-mounted luminaires, devices, outlets, etc., they are shown for circuiting clarification and are not intended to be installed outside of the building. Provide such conduit, raceway and cabling work within the confines of the building, concealed wherever possible.

1.7 SUBMITTALS

- A. Refer to Division 1 Section pertaining to Submittals.
- B. Refer to Section 260503, Submittals for Electrical Systems.

- C. Provide Equipment List for items of material and equipment, which must be reviewed by the Engineer prior to the start of work. Provide submittals in a timely manner allowing for long lead items. No item of equipment will be permitted on the site until acceptance of that equipment has been given. Provide copies of drawings and manufacturer cuts and performance data for Engineer's review. Organized in same order as listed in equipment list and include reference to page and paragraph numbers of the specifications. Do not purchase material until the final versions of the submittals are reviewed by the Design Professionals as "No Exceptions" or as "Exceptions Noted".
- D. Clearly indicate sufficient definition in submittals so they can be properly reviewed for compliance with documents.

1.8 MATERIALS AND EQUIPMENT

- A. Unless specifically indicated otherwise provide (furnish and install) all specified and drawn equipment, raceway, boxes, luminaires, controls, wiring, cabling, supports and other materials as required to render all electrical and electrically operated equipment, luminaires, devices, etc. fully operational. Unless specifically indicated otherwise provide (furnish and install) all materials that are specified under Division 26. Discrepancies or uncertainties perceived by a bidder, or other questionable interpretations by a bidder, are subject to final interpretations and decisions by the owner's representative unless addressed before bidding by addendum or unless qualified or excepted within bids.
- B. Provide material manufacturers equivalent in quality, performance, aesthetics, and product support (factory and local) to that specified as basis of design. Other products, materials, articles, devices, luminaires or forms of construction not mentioned as basis of design, required or acceptable is subject to review by the Design Professional and possible rejection. Listing of a manufacturer by name alone as an acceptable product within these specifications shall not necessarily equate another manufacturer or model to what is specified. Provide materials with manufacturing, aesthetic, durability, duty, dimensional and performance characteristics equal to or exceeding the quality, performance and characteristics of the basis-of-design specifications and products.
- C. Provide materials that are new, full weight, of the best quality. Provide similar materials that are of the same type and manufacturer. Provide materials, apparatus and equipment with Underwriter's Laboratory, Inc. label where regularly supplied.
- D. Maintain safety and good condition of the materials and equipment installed until final acceptance by the Owner. Store materials to prevent damage and weathering prior to installation.
- E. When several materials, products or items of equipment are specified by name for one use, select one of those specified.
- F. Bear costs, if any, incurred from deviation from basis-of-design equipment, luminaires, materials, methods, etc. Use of equipment, luminaires, materials, methods, etc. that deviate from

the basis of design will be considered as a statement that clearances, arrangements, performance, etc. have been checked, found satisfactory, and is compliant with applicable codes and regulations.

- G. Wire and connect electrical equipment furnished under this branch of work, other branches of work and by the owner. Review documents of other trades to identify electrically operated/controlled equipment that is furnished or installed by the owner, or by other trades. Provide power connections and local disconnects for same. Provide control wiring (including relays, starters, etc.), as required to render equipment fully operable unless indicated otherwise on drawings or in project manual. Determine exact requirements in field from respective equipment installer.
- H. Test and field-verify the following conditions prior to applying power to any luminaires, equipment, etc. Take corrective action if necessary to ensure systems and equipment are energized safely and to proper and properly configured power sources.
 - 1. Proper and expected voltages and service configurations exist at service entrance(s).
 - 2. Proper and expected voltages and configurations exist at all facility power sources.
 - 3. Current-carrying conductors are connected to the correct lines/phases.
 - 4. Grounded (neutral) conductors are properly referenced and connected.
 - 5. Grounding electrode and equipment grounding conductors are properly referenced and connected.
 - 6. Ground resistance complies with NFPA 70 and other specified requirements.
- I. In cases where luminaires, devices, equipment, or other electrical materials are furnished by Owner or others, provide the following services: receive, transport and securely store materials on site; remove materials and components from packaging; assemble all materials and components per factory instructions; install, wire and connect materials and components as recommended by manufacturer for a fully operational installation.
- J. Except where otherwise indicated, provide fully-rated or series-rated overcurrent protection (OCP). If fault current values are not indicated at nodes on drawings, also provide fault current calculations and furnish results with equipment submittals. Provide equipment and OCP rated to meet or exceed the calculated available series-rated fault current at the respective node in the power distribution system. Furnish electronic copies of the electrical documents to the manufacturer's representative and/or equipment supplier so that properly rated and braced equipment is provided under base bid.

1.9 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver equipment and materials according to factory shipping requirements. Pack components in factory-fabricated protective containers. Deliver units in sections of such size as will pass through available openings.
- B. Store equipment and materials in clean dry place and protect from weather and construction traffic. When stored inside, do not exceed structural capacity of the floor.

- C. Handle and rig work for equipment and products as recommended by the manufacturer. Do not install components and equipment damaged during shipment or handling - return damaged components to the manufacturer and replace with new.

1.10 QUALITY ASSURANCE

- A. Provide references on request that demonstrate ability to perform work of this division, including list of past projects similar in size, scope of work and complexity.
- B. Interpret specifications in connection and conjunction with the drawings. If work is shown on drawings and not mentioned in the specifications, or vice versa, provide the work as though clearly set forth by both.
- C. Provide materials and labor required to fully complete the work even though each item necessarily involved may not be specifically mentioned or shown. Provide such work and materials of the same grade or quality as the parts actually specified and shown.
- D. Provide the quantity and quality levels indicated as a minimum. In complying with these requirements, indicated numeric values are minimum or maximum, as appropriate for the context of the requirements. Should there be a conflict between the plans and specifications, provide the greater quantity and better quality.
- E. Install equipment and materials in strict accordance with manufacturer's written instructions.
- F. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified by applicable UL Standards. Accomplish tightening by utilizing proper torquing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Ensure that sealing grommets expand to form watertight seal.
- G. Upon completion of installation of equipment and electrical circuitry, energize circuitry and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- H. Prior to energizing, check installed wires and cables with megohm meter to determine insulation resistance levels to assure requirements are fulfilled. Prior to energizing, test wires and cables for proper phase to phase connections, for electrical continuity and for short-circuits. Ensure that direction of rotation of each motor fulfills requirement.
- I. Furnish the service of an experienced superintendent who is constantly in charge of the work, together with qualified journeymen, wiremen and specialists as required to properly install, connect, adjust, start, operate and test the work involved.

- J. The superintendent's qualifications are subject to the review and acceptance by the owner's representative. Unless the owner's representative grants prior special permission, utilize the same electrical superintendent throughout the duration of the project.

1.11 CLEANING EQUIPMENT AND PREMISES

- A. Clean parts of the apparatus and equipment. Clean exposed parts of cement, plaster and other materials. Remove oil and grease spots. Carefully wipe such surfaces and neatly scrape out corners and cracks.
- B. Brush down exposed metal work with steel brushes to remove rust and other spots and leave them smooth and clean. Remove trapped elements during cleaning and flushing period, after which replace and adjust them.
- C. During the progress of the work, clean up and leave the premises and portions of the building in which work has occurred in a clean and safe condition. Provide this cleaning on a per-shift basis.

1.12 PROJECT CLOSEOUT

A. General

1. Refer to Division 1 Section pertaining to Project Closeout.
2. Refer to Section 260503.00, Submittals for Electrical Systems.
3. Final payment will not be made until receipt, review and acceptance, by the owner's representative, of documentation defined under Project Closeout and in Section 260503.00, Submittals for Electrical Systems.
4. Test electrical work and ensure that it rings entirely free from ground.
5. Provide proper instruction of equipment and systems to the satisfaction of the owner's representative.
6. Make arrangements for meetings at such times as will be convenient to entities concerned for the purpose of instructing the designated personnel on the correct operation and maintenance of each individual system furnished and each system installed.

B. Record Documents

1. Obtain two complete sets of electrical prints and use them to provide progress record drawings which are separate, clean, prints reserved for the purpose of showing a complete picture of the work as actually installed (including routing of conduit and cables). These drawings also serve as work progress report sheets. Make notations, neat and legible thereon daily as work proceeds. Make these drawings available for inspection at all times and keep them at the job at a location designated by the owner's representative.
2. Maintain the clean, undamaged set of prints of drawings as well as a set of submittal drawings and coordination drawings. Mark the sets to show the actual installation where the installation varies from the Documents as originally shown. Include locations of underground and concealed items if placed other than shown on the Documents. Do not

permanently conceal construction until this required information is recorded. Mark which drawing is most capable of showing conditions fully and accurately. Where shop drawings are used, record a cross-reference at the corresponding location on the Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.

3. Show changes in: size, type, capacity, etc., of material, device or piece of equipment, location of device or piece of equipment; location of outlet or source of building service systems; routing of piping, conduit, or other building services. Record location of concealed equipment, electrical service work, conduits and other piping/work by indication of measured dimensions to each line from readily identifiable and accessible walls or corners of building. Indicate approved substitutions, modifications, and actual equipment and materials installed.
4. Affix near the titleblock on each drawing the Contractor's Company Name(s), signature of Contractor's Representative(s) and current date.
5. For electrical work installed below slabs, pavements, grade, etc., record location of nearby concealed water piping, sewers, wastes, vents, ducts, conduit and other piping, etc. by indication of measured dimensions to each line from readily identifiable and accessible walls or corners of building and from adjacent electrical work. Show invert elevation of underground electrical work relative to work installed by other trades.

1.13 WARRANTY/GUARANTEE

A. General

1. Provide a warranty/guarantee in written form stating that work, materials, equipment and parts are warranted to be free of defect for a period of one year from the date of owner's final acceptance, and defects will be repaired, revised or replaced (owner's option) at no cost to the owner if such defects occur within the guarantee period. Also state in written form that occurrences arising during the warranty/guarantee period will be attended to in a timely manner and will in no case exceed four (4) working days from date of notification by owner. Replace defective items to the satisfaction of the owner's representative and the Engineer.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 260501

SECTION 260502 - COMMON ELECTRIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 GENERAL

- A. Furnish and install all labor and material, tools and equipment necessary to render all systems complete and operational, and ready for turnover to Owner.

1.2 ACTION SUBMITTALS

- A. Refer to Section 260503, Submittals for Electrical Systems.
- B. Product Data: For lock-out/tag-out devices, access doors, sealants and fire/smoke stopping products.

1.3 INFORMATIONAL SUBMITTALS

- A. Refer to Section 260503, Submittals for Electrical Systems.
- B. Welding Certificates.

1.4 WELDING

- A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel." Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.5 HEIGHT OF BOXES

- A. Outlet mounting heights as indicated on the plans are approximate. Determine the exact mounting heights (and locations) of outlets in the field with relation to architectural detail and equipment being served. Coordinate outlet location with equipment, with furniture plans and with architectural elevation plans. Where mounting heights are not detailed or dimensioned, contact the owner's representative for direction.
- B. Prior to rough-in, coordinate final mounting heights of system outlet boxes in field with Owner's representative. Install boxes at heights as follows, to center of box, unless directed otherwise in field or otherwise noted on E-series drawings or architectural plans. In cases where using center of box for measurement would result in a switch-height device having an operable component higher than 48 inches above finished floor, install boxes lower as needed so that uppermost part of operable component is no higher than 48 inches. Height of boxes dimensioned from ceiling apply to rooms having ceilings 9' or less; in rooms having higher ceilings, locate these as directed in the field.

Switches – Counters: heights)	44” (field verify & match counter receipt.
Switches – Elsewhere:	46”
Occupancy Sensors – Wallbox:	46”
Occupancy Sensors – Elsewhere:	As recommended by manufacturer
Receptacles – Counters:	44” (field-verify)
Receptacles – Elsewhere:	18”
Proximity/Card Readers & Keypads	46”
Telephone Outlets - Desk Phone	18”
Telephone Outlets - Wall Phone	46”
Data Outlets	18”
RF (TV) Outlets - Wall/Ceiling	As indicated on drawings
Fire Alarm Manual Pull Stations	46” to top of operating handle
Fire Alarm A/V Annunciators	80” to bottom of outlet box
Other Outlets/Fixtures/Equipment	As directed by Architect

1.6 ACCESS DOORS

- A. Do not use access doors unless special prior written permission is granted from the Owner's representative. Install pull boxes, junction boxes, etc. in areas which are accessible after completion of construction. Do not install pull boxes or junction boxes above gypsum board or similar inaccessible ceiling systems. Where there is no other recourse but to provide an access door/panel, and where approval of Owner's representative has been obtained, provide required access doors/panels as required for a complete code-compliant electrical installation as defined below.
- B. For installation in masonry, concrete, ceramic tile and wood paneling provide 1 inch-wide-exposed perimeter flange and adjustable metal masonry anchors. For gypsum wallboard and plaster provide perforated flanges with wallboard bead. For full-bed plaster applications provide galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.
- C. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces. Adjust hardware and panels after installation for proper operation. Provide locking devices that are flush screwdriver-operated cam locks.
- D. Provide factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Provide continuously welded steel joints and seams, with welds ground smooth and flush with adjacent surfaces. Provide frames that are 16-gage steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast or cast-in-place concrete, ceramic tile and wood paneling. Provide Standard Flush Panel Doors that are 14-gage sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint. Provide Fire-Rated Units that are insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
- E. Provide unit assemblies that are rated for the respective fire and/or smoke rating of the surface to which they are installed.

F. Subject to compliance with requirements, provide products by one of the following:

1. Bar-Co., Inc.
2. J.L. Industries.
3. Karp Associates, Inc.
4. Milcor Div. Inryco, Inc.
5. Nystrom, Inc.

1.7 LOCK-OUT TAG-OUT DEVICES

A. Provide permanently installed lock-out tag-out devices compliant with NFPA 70 and OSHA, with padlocking provisions, at source overcurrent devices for the following applications.

1. Where the normal NFPA 70-compliant location of the disconnecting means is impracticable or introduces additional or increased hazards to persons or property.
2. Where otherwise required by NFPA 70.
3. Where required by OSHA.
4. Where otherwise required by any other authority having jurisdiction.
5. Where indicated in specifications.
6. Where indicated on drawings.

1.8 ELECTRICAL INSTALLATIONS

A. Install work conduit, wiring, outlet box type work in finished areas concealed. Such work installed in unfinished areas may be exposed at the discretion of the Owner's representative.

B. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work.

C. Provide systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible.

D. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and architectural/structural components.

E. Install electrical equipment to facilitate servicing, maintenance, and repair and replacement of equipment components. Install equipment for ease of disconnecting, with minimum of interference with other installations. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope. Protect the structure, furnishings, finishes, and adjacent materials.

F. Verify dimensions by field measurements. Take measurements and be responsible for exact size and locations of openings required for the installation of work. Figured dimensions are reasonably accurate and should govern in setting out work. Where detailed method of

installation is not indicated or where variations exist between described work and approved practice, follow direction of the owner's representative.

- G. Provide branch subfeeder circuits as shown on the plans. The symbols used to indicate the purpose of which the various outlets are intended are identified in the Electric Legend. Where outlets are indicated by letters on plans, provide corresponding switches to control them.
 - H. Provide no wire size smaller than No. 12 for branch circuits unless otherwise noted on plans for control circuits. Provide larger sizes where required by prevailing codes or indicated on contract documents. Provide neutral conductor for all multi-pole feeders. Provide neutral conductor(s) for all multi-pole feeders and branch circuits unless this contractor determines in field that the affected load(s) will never have need for a neutral conductor and NEC does not mandate otherwise. Provide minimum 3/4" conduit size.
 - I. Do not install device wall outlets directly back to back, where located on opposite sides of common walls. Offset outlets by at least two feet for applications in fire rated walls and smoke rated walls and applications in acoustically treated walls. Offset outlets by at least one foot for other applications.
 - J. Provide wires continuous from outlet to outlet and properly splice joints. Provide insulation value for joints 100% in excess of that of the wire. Mechanical wire splicers may be used. Where friction and rubber tape is used, provide tape conforming to Federal Specifications HH-T-11 and HH-T-111. Where plastic electrical tape is used, provide Scotch #33, or approved equal. Provide minimum 8" tail for conductors terminating at each wired outlet at their outlet fittings to facilitate installment of devices, luminaires, etc.
 - K. If during construction it becomes apparent that some specific minor changes in layout will effect a neater job or better arrangement, make such alterations without additional compensation and without having to offer credit.. Obtain Engineer's review before making such changes.
 - L. Provide workmanship throughout that conforms to the standards of best practice. Marks, dents and finish scratches are prohibited on exposed materials, luminaires, fittings, etc. Clean inside of panels and equipment boxes.
- 1.9 CONNECTORS
- A. Provide complete assembly of materials for each type of required electrical connection, including but not limited to, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire-nuts, and other items and accessories as needed to complete splices and terminations of types indicated.
 - B. Unless otherwise indicated, provide wires/cables (conductors) for electrical connections that match, including sizes and ratings, of wires/cables that are supplying electrical power. Provide copper conductors with conductivity of not less than 98% at 90 degrees C.

- C. Provide electrical connectors and terminals that mate and match, including sizes and ratings, with equipment terminals, and that are recommended by equipment manufacturer for intended applications.
- D. Provide electrical insulating tape, heat-shrinkable insulating tubing and boots, wirenuts, cable ties, etc. as recommended for use by accessories manufacturers for intended applications.
- E. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment. Cover splices with electrical insulating material to achieve insulation at least 100 percent in excess of electrical insulation rating of those conductors being spliced. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Do not "ring" copper conductors while skinning wire.
- F. There may be cases where circuit or feeder conductor sizes are too large or too small to fit into the lugs normally supplied with the end-use equipment, due to circumstances such as increasing conductor sizes to offset voltage drop, unusual breaker frame sizes, etc. In such cases provide appropriate factory lug kits for affected equipment if recommended by manufacturer; elsewhere provide insulated butt-splices with tails sized to fit respective lugs.
- G. Provide connectors that are specifically UL listed and labeled for the exact splicing/termination application, including for instances where solid conductors are spliced/connected to stranded conductors.
- H. Ground metal frames of portable and stationary direct-wired electrically operated equipment by connecting frames to the circuit equipment grounding conductor and to grounded metal raceway. Provide necessary electrical connections between the specified equipment and junction boxes, disconnect switches, and starters near equipment with flexible metallic conduit and matched connectors. Do not expose flexible conduit in finished areas.
- I. Connect electrical equipment furnished under this branch of work, other branches of work and by the owner. Review documents of other trades to identify electrically operated/controlled equipment that is furnished or installed by the owner, or by other trades. Provide power connections and local disconnects for same. Provide control wiring (including relays, starters, etc.), as required to render equipment fully operable unless indicated otherwise on drawings or in project manual. Determine exact requirements in field from respective equipment installer.

1.10 COORDINATION

- A. Commence with coordination in a timely manner. Subsequent additional compensation, special allowances, additional construction time, etc. will not result from failure to coordinate (including providing related information to other trades for review) in a timely manner. Do not fabricate or install work before properly coordinating with other trades.
- B. Plans are diagrammatic indicating design intent and indicating required size, points of termination and, in some cases, suggested routes of raceways, etc. However, it is not intended

that drawings indicate fully coordinated conduit routing, necessary offsets, etc. The drawings are an outline to indicate the approximate location and arrangement of ductwork, piping, equipment, outlets, raceways, cables, etc. Install piping, conduit, raceways, cable assemblies, etc. as straight as possible and symmetrical (perpendicular to or parallel with) with architectural items. Work in and on the building installed diagonal to building members is prohibited.

- C. Consult the plans of other trades while planning installations and before installing work so that work will not interfere with that of other trades.
- D. Refer to Section 260533.00, Raceways and Boxes for Electrical Systems, for special material and installation requirements that relate to coordination.
- E. Participate in multi-trade coordination efforts. Provide electrical coordination drawings, and participate in preparation of coordination drawings by other trades, prior to fabrication or installation of equipment, materials, etc. Coordinate actual clearances of installed equipment. Coordinate exact location of electrical outlets, lighting fixtures, conduits, raceways, equipment, cable assemblies, applicable devices, etc. well in advance of installation so there will be no interferences at installation between the various trades.
- F. Ensure that work and working clearances in electrical rooms and similar spaces complies with NEC Article 110. This also applies to finalizing locations of disconnects, starters, contactors and other electrically operated equipment that may require testing or maintenance while energized. Layout all affected equipment on paper, and meet with electrical inspector on-site as needed, prior to ordering related materials or commencing with installations, to ensure compliance with NEC Article 110.
- G. Coordinate and correct conflicts in equipment and materials prior to installation. If a conflict cannot be resolved, refer the matter to the owner's representative for a final decision as to method and material.

1.11 CUTTING, PATCHING AND SEALING

- A. Related Requirements:
 - 1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.
 - 2. Section 260544.00 "Sleeve and Sleeve Seals for Electrical Raceway and Cabling" for penetrations.
- B. General
 - 1. Comply with requirements of Division 07 "Thermal and Moisture Protection".
 - 2. Provide cutting and patching for the admission of work. Perform cutting, fitting, and patching for electrical equipment and materials as required to:
 - a. Uncover Work to provide for installation of ill-timed Work.

- b. Remove and replace defective Work.
 - c. Remove and replace Work not conforming to requirements of the Contract Documents.
 - d. Remove samples of installed Work as specified for testing.
 - e. Install equipment and materials in existing buildings.
3. Upon written instructions from the owner's representative, uncover and restore work to provide for observation of concealed work by owner's representative or by inspection authority having jurisdiction.
 4. During cutting and patching operations, protect adjacent installations (structure, finishes, furnishings, etc.). Where applicable, provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to system components and components of other trades.
 5. Patch surfaces and building components using new materials matching existing materials as applicable and using experienced Installers. Refer to Division 1 for definition of experienced "Installer" or determine qualifications as directed in field by owner's representative.
 6. Patch through fire rated walls and enclosures in a manner that does not diminish the rating of that wall or enclosure. Provide materials used for patching to meet or exceed the smoke and fire rating of the respective surface being patched.
 7. Neatly cut and drill openings in walls and floors required for the installation. Secure approval of Owner's Representative before cutting and drilling in work that is already in place. Neatly patch openings cut.
 8. Hold cutting and patching to a minimum by arranging with other trades for sleeves and openings before construction is started.
 9. Provide factory-assembled watertight wall and floor seals, of types and sizes required; suitable for sealing around conduit, pipe, and tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.
 10. Fabricate pipe sleeves from Schedule 40 rigid, heavy wall, full weight galvanized steel pipe; remove burrs. Use sleeves which are two standard sizes larger than conduit passing through respective sleeve.
 11. Provide sleeve seals for piping which penetrates foundation walls below grade, exterior walls and roofs, caulk between sleeve and pipe with non-toxic, UL-classified caulking material to ensure watertight seal. Elsewhere modular provide mechanical type seals, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.
 12. Provide standard Schedule 40 black steel pipe sleeves two sizes larger than pipes passing through floors, bearing walls and masonry construction. Cut sleeves through walls flush with both faces. Extend sleeves through floors one inch above floor top elevation. Provide a pipe curb assembly equal to Pate Co. for piped penetrating roof. Furnish and set forms required in masonry walls and foundations to accommodate pipes.
 13. Seal all new floor, ceiling, wall, slab, etc. penetrations to match or exceed existing assembly fire ratings. Provide sleeve seals for all sleeves, provide sleeves for all penetrations. All penetrations of fire-rated or smoke-rated wall, floors ceilings, etc. shall be sealed immediately after raceways are installed. All new electrically related work shall be supported directly from building structural members. New electrically related work shall not be supported from ductwork, ductwork hanger, ceiling supports, existing

conduit support, etc. All conduits (and cable assemblies, where applicable) shall be routed parallel to building structural members. Any and all noncomplying work installed by the electrical contractor shall be removed and reinstalled to the satisfaction of the owner's representative and the engineer, at the expense of the electrical contractor.

C. Grout

1. Provide non-shrink, nonmetallic grout, premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout, recommended for interior and exterior applications.

D. General Joint Sealer Application

1. Provide joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
2. Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.
3. Clean affected surfaces, joints, etc. immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
4. Apply sealant primer to substrates as recommended by manufacturer. Protect adjacent areas from spillage and migration of sealant, using masking tape. Remove tape immediately after tooling without disturbing seal.
5. Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
6. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealers.
7. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.
8. Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
9. Provide colors for exposed seals that are selected by the Owner's representative from manufacturer's standard colors.

E. Elastomeric Joint Sealers

1. Comply with requirements of Division 07 Section "Joint Sealants".
2. Provide one-part, nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer.
3. Provide one-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes. Provide silicone sealant equal to the following:
 - a. "Dow Corning 790", Dow Corning Corp.
 - b. "Gesil N SCS 2600", General Electric Co.
 - c. "Dow Corning 786", Dow Corning Corp.

F. Acrylic-Emulsion Sealants

1. Provide one-part, non-sag, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications of interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent. Subject to compliance with requirements, provide one of the following:
 - a. "Chem-Calk 600", Bostik Construction Products Div.
 - b. "AC-20", Pecora Corp.
 - c. "Sonolac", Sonneborn Building Products Div.
 - d. "Tremco Acrylic Latex 834", Tremco, Inc.

G. General Fire Stopping Material Application

1. Fire stopping requirements/locations are not indicated on electrical drawings. Review architectural and other drawings to determine fire/smoke rated walls and floors and rating requirements of same. Provide required fire stopping work associated with electrically related penetrations. Provide fire stop pillows, putty or sealant, as applicable, with minimum UL classification for 3 hour fire and cold side temperature ratings.
2. Clean affected surfaces, joints, etc. immediately before applying fire stopping to comply with recommendations of manufacturer.
3. Comply with fire stop material manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
4. Install fire stop materials, including forming, packing, and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.
5. Caulk between sleeves and pipes with rockwool and caulk around sleeves with sealing compound that meets applicable fire ratings required.
6. Provide patch equal to rockwool, firestop, caulk or approved "rated" patch.
7. Where a smoke or fire-resistance classification is indicated on architectural drawings or otherwise, provide the following as applicable.
 - a. Fire stop pillows, putty or sealant with minimum UL classification for 3 hour fire and cold side temperature ratings for electrically related penetrations.
 - b. Access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating required; Provide UL Label on each fire-rated access door.

H. Wall/Floor Opening Fire Stopping for Work Likely to Need Ongoing Moves/Adds/Changes

1. Provide Fire Stop Putty equal to Nelson FSP #AA400 series, UL Classified for 3 hour fire and cold side temperature ratings, reusable when penetrating items are removed or added and requiring no special tools, mixing, curing or drying time.

I. Fire Stopping for Other Wall and Floor Openings

1. Provide Fire Stop Sealant equal to Nelson #AA491 series, UL Classified for 3 hour fire and cold side temperature ratings, non-sagging, permanently flexible, non-toxic, non-

shrinking, water/air/smoke-tight and easily re-penetrated. Provide firestopping materials for the following locations:

- a. For Floor Openings
 - b. For Wall Openings
 - c. For Insulated Pipes
 - d. For Fill Areas
2. Apply sealant primer to substrates as recommended by manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.
 3. Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or that are not approved by sealant manufacturer.

PART 2 - PRODUCTS (INCLUDED IN PART 1 ABOVE AS APPLICABLE)

PART 3 - EXECUTION (INCLUDED IN PART 1 ABOVE AS APPLICABLE)

END OF SECTION 260502

Submittal Form - 260502.00 – Common Electrical Materials And Methods

Provide And Complete This Sheet And Submit As A Cover Sheet For Submittals Requested Within This Section.

Electrical Contractor: _____ Electrical Supplier: _____

Electrical Contractor Rep: _____ Electrical Supplier Rep: _____

Electric Contractor Ph. Number: _____ Electric Supplier Ph. Number: _____

Electric Contractor Rep Email: _____ Electric Supplier Rep Email: _____

Submitted Access Door Manufacturer: _____

Submitted Sealant Manufacturer: _____

Submitted Fire/Smoke Stopping Product Manufacturer(S): _____

	Yes	No
Manufacturers Listed As Basis Of Design Or Listed Equivalent Manufacturers?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Welder Certificates Included?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Manufacturer's Warranties Meet Or Exceed The Warranty Period Specified?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Lock-Out/Tag-Out Devices, Sealants, Fire/Smoke-Stopping And Access Doors Included?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Coordination Drawings Included?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		

SECTION 260503 - SUBMITTALS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections and Division 26 Common Requirements for Electric.
- B. Submittal Forms are included at the end of most Division 26 specification sections, addressing action submittals and applicable information submittals. Include the form as the secondary cover sheet for action submittals and applicable information submittals of each affected section. Note that other submittals are also required as part of the project, even though they may not be addressed in these Submittal Forms.

1.2 SUMMARY

- A. Section Includes: Administrative, content and format requirements for preparation and submission of submittals.
- B. Work of this Section is supplemental and additive to the requirements of Section 013300 where included in the Project Manual.

1.3 PRICE AND PAYMENT PROCEDURES

- A. Payment in full or in part may be withheld from the Contractor for failure to comply with submittal requirements articulated in the Contract Documents.

1.4 SUBMITTALS

- A. Submittals shall be furnished for each Section that includes one or more of the following elements of work:
 - 1. Supply of one or more products.
 - 2. Installation of one or more products.
 - 3. Integration of one or more products.
 - 4. Programming of one or more products.
 - 5. Creation of one or more deliverable products.
 - 6. Labeling of one or more products.
 - 7. Contractor-based design or engineering of one or more products or systems.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Submittals shall be routed through established Project channels as identified by the Owner's representative.
- B. Coordinate, assemble, title, transmit and track Project submittals.
- C. Label each submittal of each type similarly for consistency and so they appear as if prepared by the same entity. Like-type submittals (e.g., Product Data) from different Sections shall have the same appearance and organization as those of other Sections.
- D. Submittals prepared by subcontractors or vendors shall not be accepted unless prepared in compliance with the Contract Documents.
- E. Submittal items listed in this Section represent the common items required to be supplied for the various specification Sections throughout the duration of the Project. Individual Sections will vary and may include additional or lesser requirements.
- F. Design Professional reserves the right to require additional submittals or to waive select submittal requirements on a Section-by-Section basis.
- G. The cost for preparation and transportation of submittals is Work of the Contract.
- H. Bind physical/hardcopy submittals together. Do not submit loose or paper clipped documents.
- I. Supply separate submittals for each Section. Do not combine multiple Sections together into a single submittal, except where expressly directed within the Contract Documents.
- J. Where electronic submittals are required or permitted, comply with the requirements for electronic submittals as identified in the Contract Documents.
- K. Organize submittals as identified in the Contract Documents.
- L. Furnish submittals for different Sections each with its own transmittal form. A single transmittal shall not be used to identify submittals for more than one (1) Section at a time. This allows for tracking and processing efficiency, so that:
 - 1. Each Section may be reviewed simultaneously by different individuals, as appropriate.
 - 2. Individual Sections may be processed and returned more quickly than others when some Sections require longer review times.

3. Submittals that are returned and marked as “Revise and Resubmit” do not cause submittals for other Sections to be also be resubmitted due to the fact that they were bound together as a single unit.

M. Use of Electronic Drawings from the Owner’s Design Team:

1. Plan drawings for the Project were created with AutoCAD .
2. If expressly permitted by the Owner and the terms of the Contract, editable electronic versions of standard-scale, AutoCAD-based plan drawings may be made available for the creation of shop and as-built drawings.
3. Due to the proprietary nature of internal design systems, editable native-software versions of some drawings, including but not limited to system diagrams and details will not be made available in an editable form. In these cases, electronic versions of the drawings may be made available only in PDF, JPG or similar non-editable electronic form, at the sole discretion of the Design Professional.
4. The Request Drawings form can be accessed, filled out and submitted at the following internet address (scroll down to bottom of home page): <http://www.klhengrs.com>.

3.2 SUBMITTAL TYPES

A. The following are the common submittal types referenced in this Section:

1. Quality Assurance (QA).
2. Quality Control (QC).
3. Product Data (PD).
4. Shop Drawing (SD).
5. Samples (SS).
6. Training (TG).
7. Field Observation Response (FO).
8. Closeout Submittal (CO).

3.3 SEQUENCE

A. Quality Assurance Submittal:

1. When not expressly requested to be supplied with bid, the Quality Assurance submittal(s) shall be supplied upon request. When requested the submittal shall be delivered to the Design Professional within 16 business hours.

B. Product Data Submittal:

1. Submit following contract award or notice of intent to award a contract. Product data shall be submitted and reviewed prior to procurement of materials.

C. Shop Drawing Submittal:

1. Submit for review prior to commencement of fabrication and installation.

2. Submit concurrently with Section-specific Product Data submittals.

D. Samples Submittal:

1. Submit concurrent with, or soon after, product data and shop drawings and prior to installation of Work.

E. Training Submittal:

1. Submit thirty (30) days prior to the first training session.

F. Field Observation Report Submittal:

1. Submit five (5) business days prior to punch list walkthrough.

G. Closeout Submittal:

1. Submit following completion of onsite work but not more than ten (10) business days following successful Acceptance Testing.

3.4 IDENTIFICATION

A. Identify each submittal uniquely.

B. Identify each submittal by specification Section number, submittal type, and submittal iteration.

C. The format for labeling the submittals shall be as follows:

1. Section Number–Submittal Type Abbreviation–Submittal Iteration.
2. Examples:
 - a. First Product Data Submittal for section 261513: “261513-PD-00.”
 - b. Revised Product Data Submittal for section 261513: “261513-PD-01.”
 - c. Second Revised Product Data Submittal for 261513: “261513-PD-02.”

3.5 CONTENTS

A. General:

1. Transmittal:
 - a. Supply a dedicated transmittal for submittals for each individual Section.
 - b. Itemize the specific submittals included by Section, submittal type, and iteration.
2. Title Sheet:
 - a. Include a separate title sheet with each submittal, of each type.
 - b. Title sheets for each Section, for each submittal type, shall have the same appearance.

- c. Title sheets for product data submittals shall be 8-1/2 inches x 11 inches.
 - d. Title sheets for drawings shall be the same size as the associated drawings.
 - e. Create title sheets to have the appearance and information identified on the sample title sheet published at the end of this Section.
3. Index:
 - a. Include an index outlining and identifying the contents of the submittal.
 - b. The index for drawing submittals shall be incorporated onto the title sheet of the corresponding drawing set.
 4. Checklists:
 - a. Include the checklist(s) published in the Contract Documents corresponding to the type of submittal being supplied. Applicable checklists are found at the end of this Section and within individual Sections.
 5. Title Blocks:
 - a. Drawing submittals shall be created on the Contractor's, manufacturers, or vendor's own title block. The title blocks of the Owner, Architect, Engineer, Design Professional or their Consultants shall not be reproduced on any document (electronic or hardcopy) that is prepared or altered by the Contractor.
 6. Legend:
 - a. Drawing submittals shall include a legend of symbology.
 7. Resubmittals:
 - a. Resubmittals shall include a replica of the reviewer's comments that necessitated the resubmittal, along with an accompanying item-by-item explanation of the actions taken and changes that will be found within the resubmittal.
- B. Quality Assurance:
1. List of Subcontractors to be used on the Project along with a description of the role each shall play on the Project.
 2. The last six (6) projects that the Contractor (and each proposed Subcontractor) has completed that are of similar scope, size and contract value. References shall include:
 - a. Owner's name and current contact information.
 - b. Project address.
 - c. Description of the system(s) and scope of actual work performed.
 - d. Monetary contract value of the Work performed.
 3. Financial Disclosure of the Contractor: Prior to contract award, upon request.
- C. Product Data Submittals:
1. Bill of Materials (BOM):
 - a. Separate list for each system:
 - 1) When a Section covers products for use in multiple systems, supply separate BOM for each unique system covered by the Section. Label each with the system name, space/room name, and room number.

- b. Include the following:
 - 1) Make, model, and description of each product.
 - 2) Quantity estimates for each product.
 - 3) Section paragraph number from which the product requirement is derived. Use drawing and detail references when the requirement is derived from the Drawings.
 - c. Organize the BOM to follow the order in which products appear within the Section. Products shown on the Drawings but not enumerated within the Specifications shall be placed at the end of the list and include a reference to the Drawing from which the product requirement was derived.
2. Product Datasheets:
- a. Separate manufacturer datasheets for each product.
 - b. Datasheets shall be manufacturer originals or first generation printed versions (i.e., from PDF) of the manufacturer's official electronic datasheet:
 - 1) Distributor modified, distributor branded, and/or html based "web" datasheets are not acceptable.
 - 2) Datasheets shall include size and technical support data.
 - c. Where manufacturer's datasheets depict multiple products, versions and options, indicate via highlighting, underlining, or with bold visible arrows the model(s), version(s) and option(s) being supplied. Exact catalog number(s) shall be indicated.
 - d. Each datasheet shall be labeled with the Section paragraph reference number. Datasheets shall include the Drawing reference when no specific paragraph reference exists within the Section.
- D. Shop Drawing Submittals:
1. General:
- a. Drawing descriptions identify the required contents of common drawings required under the Contract.
 - b. Drawings identified within individual Sections, along with any additional drawings deemed necessary by the Design Professional, are required.
 - c. Drawing Scales:
 - 1) Floor plans shall be drawn to scale.
 - 2) Section drawings shall be drawn to scale.
 - 3) Elevation drawings shall be drawn to scale.
 - 4) Details of physical items shall be drawn to scale.
 - 5) Rack layouts and custom furniture and console drawings shall be drawn to scale.
 - 6) System drawings and schematic drawings shall be drawn 1:1 (no scale).
 - d. Sizes:
 - 1) Sheet sizes shall match the size of the Contract Drawings sheets, except where otherwise expressly requested or approved in advance by the Design Professional.
2. Floor Plans:
- a. Location of system devices and faceplates.
 - b. Primary and secondary system cabling pathway(s).

- c. Location of equipment racks.
 - d. Location of equipment-housing furniture.
 - e. Location of equipment enclosures.
 - f. Location of major system components.
 - g. Location of equipment that is Work of another Section to which Work interconnects.
3. Reflected Ceiling Plans:
- a. Location of ceiling devices, coordinated with devices that are Work of others, and existing devices (where applicable).
4. System Diagrams:
- a. Hybrid schematic / block wiring diagram.
 - b. System products depicted.
 - c. Product inputs, outputs and other ports depicted.
 - d. System cables depicted.
 - e. Product brand, model, description, options, and accessories declared.
 - f. Interconnections depicted between system products.
 - g. Interconnections depicted between system products and related system products.
 - h. Declaration of the cable types, including brand, model, description and color. An accurate cable key is acceptable.
 - i. Unique identification (e.g., number) assignment for each cable.
 - j. Cable color coding schema.
 - k. Termination typicals, keyed to diagram interconnections.
5. Custom Assemblies and Products:
- a. Manufacturer.
 - b. Materials.
 - c. Finish and color(s).
 - d. Parts list.
 - e. Nomenclature sizes, colors.
 - f. Dimensions.
 - g. Schematic diagram(s), where applicable.
6. Mounting Details:
- a. Depicting the materials and means of securing installed products.
 - b. Finishes and colors of exposed parts.
- E. Training Submittals:
- 1. Proposed schedule.
 - 2. Training agendas for each session.
 - 3. Identification of personnel that will conduct training.
 - 4. Handouts proposed for distribution during training.
- F. Field Observation Reports Submittals:
- 1. Written responses to Field Observation Reports supplied to the Contractor during the course of the Project:

- a. The response shall include a copy of the original Field Observation Report.
- b. The response shall include detail of the corrective action taken, the date the action was taken and the identity of the individual who took the action.

G. Closeout Submittals:

1. Certificates of Final Inspection and Approval:
 - a. Furnish certificates of final inspection and approval prior to final acceptance of this branch of the work.
2. As-Built Drawings:
 - a. General:
 - 1) Requirements for Shop Drawings apply to "As-Built" drawings.
 - b. Required Drawings:
 - 1) Title Sheet.
 - 2) Floor Plans.
 - 3) System Diagrams (complete set of detailed wiring diagram and schematic drawings for components of systems furnished; provide drawings that are not factory generic information, but are complete and accurate for the equipment actually provided.)
 - 4) Power Distribution Diagrams.
 - 5) Labeling Schema.
 - 6) As-built version of each Project shop drawing.
 - 7) Coordination drawings and similar construction-related documentation.
 - c. Drawing Formats:
 - 1) Sheets shall be the same size and feature consistent title block information in the lower-right corner.
 - d. Drawing Organization:
 - 1) Hardcopy drawings shall be bound together into logical sets, bound along the left edge of the sheets.
 - 2) The first page of the set shall include a detailed index and sheet-by-sheet description of each drawing sheet.
3. Operation and Maintenance Manuals:
 - a. Manual Format:
 - 1) Hard-cover 3-ring type binder.
 - 2) Front clear plastic cover pocket complete with Project and system Information insert.
 - 3) Clear plastic spine pocket with Project and system Information insert.
 - 4) Binder sized to suit the contents only, neither oversized nor undersized.
 - 5) Maximum binder thickness: 3 inches.
 - b. Manual Contents and Organization:
 - 1) General:
 - a) Separate binder (or binder set) for each system, labeled. Provide no more than one system per binder (or binder set).
 - b) Separate CD-ROM (or CD-ROM set) for each system, labeled. Provide no more than one system per CD-ROM (or CD-ROM set).
 - c) Do not overfill. Binders shall not be filled beyond an easily usable capacity.

- d) Insert labeled tabs within binder to identify separate contents of the manual.
- e) Labeled sub-directories shall be created on the CD-ROM to label and separate contents for the manual.
- 2) Project Information Cover:
 - a) Title of Project.
 - b) Name and address of Owner, Design Professional, Architect, Contractor of Record and Subcontractor.
 - c) System name and specification references.
- 3) Index:
 - a) Contents of the manual.
- 4) Warranty Statement:
 - a) A warranty statement shall be included for each system. The warranty statement shall reiterate the terms of warranty identified within the Contract Documents, as well as identify how the Owner is to obtain warranty service.
 - b) The warranty statement shall clearly identify which products are covered by Manufacturer warranties beyond the Contractor required minimum warranty period. The term of manufacturer warranty shall also be identified (e.g., 1 year parts and labor).
 - c) A separate warranty statement shall be supplied for each system.
 - d) Identify the date that the warranty for the system starts. This date shall be the date listed on the Certificate of Substantial Completion (if one was issued to the contractor specifically for the system) or the date listed on the Notice of Final Completion.
 - e) Supply standard out-of-warranty service rates and service contact information.
- 5) Bill of Materials:
 - a) List of products supplied.
 - b) Serial numbers of each product.
 - c) IP addresses of those products configured to have static IP addresses.
 - d) MAC addresses of products featuring network communication ports (wired and/or wireless).
 - e) Network device names for those products configured for DHCP.
- 6) Product Datasheets (supply only in the electronic version of Operation and Maintenance Manual):
 - a) Manufacturer datasheets for each product supplied.
- 7) Manufacturer Owner / User Manuals:
 - a) Manufacturer's Owner's or User's manual for each product.
 - b) Manufacturer's Installation instructions and other documentation supplied with the product.
- 8) Spare and Replacement Parts Schedule:
 - a) Complete spare parts schedule for components of equipment furnished, which are not factory generic information, but accurate for the equipment actually provided.
 - b) Itemized list of each piece of mechanical equipment having electrical connections with circuit and panelboard locations; also list with each item related expendable equipment required such as fuse size and type, pilot lights, catalog numbers of fuses, overloads, etc. as applicable.

- c) Itemized list of each luminaire type with catalog number of replacement lamps, ballasts, trims, lenses and accessories.
- 9) Maintenance Procedures:
 - a) Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
- 10) Function and Operating Descriptions:
 - a) Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
- 11) Operating Procedures:
 - a) Manufacturer's printed operating procedures including start-up, break-in, normal operating instructions, regulation, control, stopping, shutdown, and emergency instructions.
- 12) Test Reports and Checklists:
 - a) Test reports, checklists, and other forms generated and completed during the course of the Project.
- 13) Training Information:
 - a) Photocopy of training outlines / agendas.
 - b) Photocopy of training session handouts.
 - c) Photocopy of training sign-in sheets.
 - d) Photocopy of signed delivery receipt for each training session recording (applicable to those Sections/systems requiring recording).
 - e) Separate CD-ROM (or CD-ROM set), labeled, for audio/video-recorded instructions to owner, for operations and maintenance for each system.
- 14) As-Built Drawings:
 - a) The hardcopy manual shall contain reduced scale printed version (11x17) of system-specific drawings.
 - b) The electronic manual shall contain electronic PDF version of the as-built drawings.
- 15) Software (electronic manual only):
 - a) Editable configuration files for system equipment.
 - b) Software source code use in supplied products.
 - c) Compiled versions of configuration files and source code.
 - d) Software required for reviewing and editing supplied files.

3.6 QUANTITY

A. General:

1. The quantity of submittals required shall be the greater of the following:
 - a. Quantity identified within Division 01.
 - b. Quantity identified within the individual Section.
 - c. Quantity identified herein.

2. In addition to the Contract required quantity, the Contractor shall also submit any additional quantities required for its own use and records, and for distribution to other trades.
3. The Design Professional shall retain a copy of each submittal received. Others in the submittal communication chain may also retain copies.

B. Product Data Submittals:

1. One (1) Hardcopy.
2. One (1) Electronic.

C. Shop Drawings Submittals:

1. One (1) Hardcopy.
2. One (1) Electronic.

D. Training Submittals:

1. One (1) Hardcopy.
2. One (1) Electronic.

E. Field Observation Reports Submittals:

1. One (1) Hardcopy.
2. One (1) Electronic.

F. Samples Submittals:

1. One (1) Hardcopy.
2. One (1) Electronic.

G. Closeout Submittals:

1. One (1) Hardcopy.
2. One (2) Electronic.

3.7 REJECTION

A. The following items are representative reasons that submittals may need to be revised and resubmitted:

1. Binding submittals for multiple Sections together.
2. Failing to supply separate transmittal for submittals for each Section.
3. Failing to include a submittal title sheet.
4. Failing to use and accurately complete the published title sheet.
5. Failing to supply and accurately complete the submittal checklists.
6. Failing to supply product data and shop drawings at the same time.

7. Failing to include a detailed BOM with the product data.
8. Failing to supply product data sheets.
9. Failing to supply product data sheets with the correct product and required accessories enumerated.
10. Failing to supply shop drawings.
11. Failing to supply shop drawings with required information.
12. Failing to supply accurate information.
13. Failing to supply relevant information required by the Specifications.
14. Failing to supply products that are in compliance with the Specifications.
15. Failing to supply the required information in the required format.

3.8 RESUBMITTALS

A. Revise and Resubmit:

1. When a submittal is rejected and flagged as “Revise and Resubmit,” the entire submittal shall be reviewed, revised and resubmitted in totality.
2. Resubmittals shall be checked for compliance with the Contract Documents, inclusive of requirements for submittals. In addition, any comments and deficiencies identified by the reviewer shall be appropriately acted upon.

B. Exceptions Noted:

1. When a submittal is flagged as “Exceptions Noted,” the specific actions identified shall be taken.
2. If the reviewer’s comments include selective rejection of products, the resubmittal shall be limited to include those items commented upon.

C. Resubmittals shall:

1. Include a copy of the reviewer’s previous comments.
2. Include a written description of the action(s) taken.
3. Be labeled chronologically.
4. Be inclusive of all corrective action identified by the previous reviewer.

3.9 ELECTRONIC SUBMITTALS

A. Provide electronic submittal files that are compatible for opening and viewing with electronic PDF file readers that fully support and recognize the Adobe PDF Portable Document Format Standard.

B. Major text within the files shall be electronically searchable using the search-for-text features of current generation Adobe PDF reader software. Files shall be prepared in such manner that reviewers will have the option to search for and find words and phrases that appear within the document, electronically. Documents featuring raster-based text and text that is otherwise not searchable shall not be acceptable. This precludes the use of documents that have been electronically scanned and then converted to or embedded within an electronic file.

C. The organization, contents, and labeling of information along with other requirements for submittals apply also to electronic versions of the submittals.

D. Single File Submission:

1. Option 1 – Single File, PDF Format:

- a. Single PDF file submittals shall be assembled from a series of individual files that are organized, indexed, bound together as one composite file that is bookmarked to aid the reviewer in navigating the content.
- b. The file shall feature a navigational tree of contents, organized by content groups (e.g., Title Page, Index, BOM, Datasheets, Shop Drawings). Content groups shall be organized in the same relative order identified within the Contract Documents.
- c. Within each content group shall be the supporting elements of the group (e.g., product datasheets under the Datasheets group). Each element of the content group shall appear separately as a subordinate element of the group (e.g., separate entry for each product datasheet, separate entry for each shop drawing), and viewable from the navigational contents tree.
- d. Under the Datasheets content group, individual product datasheet entries shall be identified by Make/Brand and Model. Entries shall be organized in a sorted manner, first by make, then by model.
- e. If the resulting size of the composite PDF file exceeds 10 Megabytes, supply the submittal using the Single Zip File method instead, as described in this Section.
- f. The file name used to label the submittal shall be the section number followed by the submittal instance number for that Section (e.g., <xx>1513-PD-01.pdf).
 - 1) Where the Design Professional directs the supply of multiple zip files for a submittal, add additional text to the file name to identify that the file is part of a multi-file set of submittals, as per the following examples:
 - a) 261513-PD-01 (1 of 3).pdf
 - b) 261513-PD-01 (2 of 3).pdf
 - c) 261513-PD-01 (3 of 3).pdf

2. Option 2 – Single File, Zip Format:

- a. Single Zip File submittals shall be assembled from a series of individual PDF files and file directories that are contained with a single compressed WinZip compatible “.zip” file.
- b. The file shall contain separate top-level directories that are used to group related content (e.g., 00-Title Page, 01-Index, 02-BOM, 03-Datasheets, 04-Shop Drawings), with each directory appearing in the same relative order as that identified in the Contract Documents.
- c. Within each content group directory shall be separate PDF-compliant files featuring the information required (e.g., separate datasheet file for each product, separate file for each drawing, separate file for each BOM).
- d. Product datasheet files shall be named using a consistent naming convention that enables those files to appear sorted and grouped when the file is opened for navigation, viewing or extraction by the reviewer.
- e. Product datasheet files shall be consistently named with the make/brand of the product, followed by model number, followed by any additional information beneficial.

- f. Consult the Design Professional for supplement instructions should the WinZip file exceed 50 Megabytes in size.
- g. The file name used for the submittal shall be the Section number followed by the submittal instance number for that Section (e.g., <xx>1513-PD-01.zip).
 - 1) Where the Design Professional directs the supply of multiple zip files for a submittal, add text to the file name that identifies the file is part of a multi-file set as per the following examples:
 - a) 261513-PD-01 (1 of 3).zip
 - b) 261513-PD-01 (2 of 3).zip
 - c) 261513-PD-01 (3 of 3).zip

END OF SECTION 260503

XXXXXXXXXX
SHOP DRAWING CHECKLIST
(Form: Sub-8)

SUBMITTAL TITLE SHEET
EXAMPLE
(Form: Sub-1)

PROJECT TITLE:
Project Name Line 1
Project Name Line 2
Project Name Line 2

SUBMITTAL TYPE:
Product Data

SECTION SUBMITTAL NUMBER
260000-PD-00

SECTION TITLE:
Section Name

Date Prepared:
yyyy-mm-dd

CONTRACTOR OF RECORD:
Firm Name
Address 1
Address 2
City, State, Zip
Phone (000) 000-0000, Fax (000) 000-0000
Project Manager: Full Name
PM E-Mail: xxxxxxxxx@xxxx.xxx

SECTION SUBCONTRACTOR(S):

Firm Name Address 1 Address 2 City, State Zip Phone (000) 000-0000 Fax (000) 000-0000 PM Name: Full Name PM E-Mail: xxxxxxxx@xxxx.xx	Firm Name Address 1 Address 2 City, State Zip Phone (000) 000-0000 Fax (000) 000-0000 PM Name: Full Name PM E-Mail: xxxxxxxx@xxxx.xx
---	---

XXXXXXXXXX
 SHOP DRAWING CHECKLIST
 (Form: Sub-8)

PRODUCT DATA SUBMITTAL

CHECKLIST
 (Form: Sub-2)

Each line below featuring text shall be supplied with an answer.

	No	Yes
Transmittal		
Title Sheet		
Project Name		
Spec Section number		
Submittal iteration number. <i>(0 for first iteration, 1 + for each subsequent iteration (e.g. 261513-0,261513-1))</i>		
Contractor of Record identified		
Sub-contractor / vendor / supplier name identified		
Title Sheet appearance consistent with sample title sheet		
Bill of Materials		
Section paragraph and/or drawing reference identified		
Make		
Model		
Product Description		
Quantity		
Separate lists included for each system.		
Checklists included		
This checklist		
Previous submittal review, with contractor actions and comments		
Product Datasheets included		
Datasheets are manufacturer originals		
Datasheets for each product included		
Section paragraph and/or drawing reference on each datasheet		
Product accessories and options identified		
Products organized by paragraph (or alphabetically by brand)		
No photocopies, faxes and other illegible datasheets included.		
Shop Drawings included		
Shop drawings accompany this product data submittal		
This submittal contains product data for one section only		

This checklist serves as simple and abbreviated reminder of the contents and format of the aforementioned submittal. Refer to the 260503 "Submittals for Electric" and each specific Section for additional submittal requirements. Submittals are subject to rejection if this checklist is not accurately completed and supplied along with the specified information. Reproduce this checklist and submit with each submittal for each Section.

SECTION 260505 - EXISTING CONDITIONS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Perform a detailed pre-bid walk-through field inspection to review the existing structures and premises, to determine existing conditions, and to determine scope of required electrically related work. Include applicable accessible ceiling cavity areas in this inspection.
- B. It is not the intent of this section, or of drawings, that existing conditions be accurately shown. Existing electrical work is shown to a very limited extent on drawings and is shown for general planning reference only. Locations and information were derived from cursory visual observations or from portions of documents that were prepared for previously installed work (not from record drawings or "as-builts").
- C. Do not reuse removed electrical materials unless specifically indicated in project manual or on drawings. Existing wiring systems may be utilized only to the extent indicated in project manual, or on drawings, or as directed by Owner's representative in field.
- D. Hold routing of new raceways in existing buildings as tightly as possible to the structure above. Obtain approval of owner's representative prior to installation.
- E. If required to accommodate construction related activities temporarily remove, store in protected location on site, and reinstall conflicting electrical equipment, luminaires, or devices that are to remain or to be relocated.
- F. The following applies to electrical materials that will remain or be reused under this project.
 - 1. Protect during construction activities.
 - 2. Clean and re-lamp luminaires immediately prior to occupancy of the finished construction area.
 - 3. Clean and service (if service is required) equipment in the construction area immediately prior to occupancy of the area.

1.2 AFFECT ON ADJACENT OCCUPIED AREAS

- A. Maintain existing electrical service and feeders to occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by owner's representative. Provide temporary service during interruptions to existing facilities. Schedule momentary outages when necessary for replacing existing wiring systems with new wiring systems. When that "cutting-over" has been successfully accomplished, remove related wiring that has been abandoned.

- B. Carefully coordinate work and system shutdowns in advance with owner's representative, and with affected trades so that normal building activities and other construction trades are minimally affected. Perform electrically related construction work, which will affect an occupied area (including those which are located outside the immediate area of project work) at special times as directed by owner's representative in field.
- C. Provide work in a manner that ensures existing systems and components remain fully operational in occupied spaces during occupied periods.
- D. Provide and maintain temporary partitions and dust barriers adequate to prevent the spread of dust and dirt to adjacent finished areas and other system components. Protect adjacent installations during cutting and patching operations. Remove protection and barriers after demolition operations are complete.

1.3 EXISTING POWER DISTRIBUTION EQUIPMENT

- A. This subsection applies for adding components to existing power distribution equipment.
- B. Unless specifically indicated otherwise on drawings or in specifications provide new breaker in instances where new circuits or feeders are shown connected to existing circuit breaker type power distribution equipment.
 - 1. Provide factory-assembled, molded-case circuit breakers of frame sizes, characteristics, and ratings including RMS symmetrical interrupting ratings required. Provide breakers with permanent thermal and instantaneous magnetic trip, and with fault-current limiting protection, ampere ratings as indicated. Construct breakers for mounting and operating in any physical position, and operating in a minimum ambient temperature of 40 deg C. Provide breakers with mechanical screw type removable connector lugs, AL/CU rated. All branch circuit breakers shall be full ambient compensated thermal magnetic molded case with quick-make and quick-break action and positive handle trip indication, both on manual and on automatic operation.
 - 2. Breakers shall be of the over-the-center toggle operating type with the handle going to a position between "on" and "off" to indicate automatic tripping. All circuit breakers shall be full size. Do not use "tandem" or "split" breakers. All multi-pole breakers shall have internal common trip with all load side box lugs of one breaker in the same gutter. All circuit breakers shall have sealed cases to prevent tampering.
 - 3. All 15 and 20 ampere branch circuit breakers shall be UL Listed as SWD (switching duty). All 15-70 ampere branch circuit breakers shall be HACR Type. All branch circuit breakers serving all ballasted (fluorescent/HID) lighting loads shall be HID rated. Provide handle lock-on devices of the non-padlocking type for life safety, special systems and other essential circuits.
- C. Provide components that are manufactured by the same manufacturer as the existing equipment in which they will be installed, and that are intended by the manufacturer to be installed in said equipment. Provide components with fault current (A.I.C.) ratings that meet or exceed the ratings of the existing power distribution equipment.

- D. Update and fill out the panelboard's circuit directory card upon completion of installation work. Directories shall be neatly typewritten. All panelboard directories shall include the actual room names/numbers that are selected for interior signage/designation.
- E. All specific scheduling shown on drawings is shown to indicate new branch circuiting requirements. Exact numbering sequence of circuits shall be determined by this contractor in field after this contractor has performed final balancing.
- F. Determine which existing branch circuits must remain active. Reconnect (or maintain in operation as applicable) and schedule them. Completely re-type panelboard directories for panelboards affected by this project using accurate "as-built" information. Where applicable for multi-wire branch circuits that are reused to feed new or replacement equipment designated on drawings, replace existing single-pole breakers with multi-pole breakers compliant with NFPA 70. Where applicable ensure that reconnected shared neutrals are properly balanced with the correct phase conductors. Where applicable, provide correct color-coding for insulation of reconnected conductors in a manner compliant with NEC.

1.4 PRE-EXISTING CODE VIOLATIONS

- A. Inspect existing electrical work in areas accessed under this project and bring into compliance with current NEC. This applies only to the extent that such work is uncovered in the immediate project areas affected by construction activities, and only to the limited extent that it applies to pre-existing general installation methods such as missing J.B. plate, open J.B. knockout, minor conduit re-anchoring and minor exposed wiring/connections.
- B. If more extensive code or safety violations are discovered, immediately bring them to the attention of the Owner's representative (detailed in writing) along with proposed cost for corrections and impact (if any) on the construction schedule.

1.5 DEMOLITION

- A. Where the term "demolition" is used herein, interpret it to mean "demolition" or "selective demolition" as applicable.
- B. Provide electrical demolition work as required to accommodate project demolition and as required to accommodate new construction.
- C. Disconnect and remove work to be abandoned, and as required to accommodate work of other trades, in areas affected by this project unless specifically noted otherwise on plans or determined otherwise during pre-demolition survey.
- D. Remove accessible abandoned, inactive and obsolete raceway systems. Remove abandoned, inactive and obsolete wiring and controls. Remove abandoned, inactive and obsolete equipment, luminaires and devices. Abandoned raceways embedded in floors, walls, and

ceilings may remain if such materials do not interfere with new installations. Remove abandoned electrical materials above accessible ceilings.

- E. Remove related abandoned unused raceway back to the nearest respective "upstream" junction box that remains active even if outside of the confines of the project area.
- F. Remove abandoned unused wiring back to its source even if sources are outside the confines of the project area.
- G. Extend raceway and wiring as required to accommodate new or relocated electrical work.
- H. Locate, identify, and protect electrical services passing through demolition areas and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
- I. It is recognized that there may be some conduit systems rendered inactive by demolition, causing disconnection of "downstream" outlets, etc. Investigate these types of conditions (for all systems) prior to demolition. Provide necessary corrective electrical work prior to demolition to ensure that such "downstream" devices remain permanently active throughout demolition, during new construction, and after project completion.
- J. Perform cutting and patching required for demolition.
- K. Coordinate work carefully with owner prior to beginning electrical demolition work.
- L. Maintain (or reconnect if applicable) remaining wiring.
- M. Remove and relocate wiring, devices, conduit, etc. that conflict with construction related work of other trades as necessary to accommodate new work of respective trade.
- N. Provide electrical disconnections, and reconnections where applicable, for equipment to be removed (or relocated) by other trades.
- O. Existing branch circuit and systems conduit, not conflicting with new construction and not conflicting with overhead or ceiling cavity requirements, may be re-used at the discretion of the electrical installer after all abandoned conductors and cables have been removed from them. Do not exceed NEC required conduit fill and do not install wiring fed from different sources in common conduit (see Section 26 05 33).
- P. Refer to owner's representative for disposal instructions for abandoned electrical materials removed during demolition and thereafter. Neatly store electrical materials that the Owner elects to retain at the site as designated by the owner's representative. Legally dispose of materials that the Owner elects not to retain.

- Q. Disconnect and remove electrical materials designated for salvage (removal and reuse, or for turning over to Owner) undamaged. Disconnect and remove wiring and "whips" from equipment terminal points.
- R. Clean components to be reused inside and out, and reinstall where indicated on drawings. Modify and extend related existing wiring in conduit accordingly.
- S. Carefully transport salvaged electrical materials to a protected on-site storage location as directed in field and neatly store them grouped by system type.

END OF SECTION 260505

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Acceptable Manufacturers: Subject to being equivalent and subject to compliance with requirements, provide product by one of the manufacturers listed below. If not listed, submit as substitution.
 - 1. Alcan Products Corporation; Alcan Cable Division.
 - 2. Alpha Wire.
 - 3. Belden Inc.
 - 4. Encore Wire Corporation.
 - 5. General Cable Technologies Corporation.
 - 6. Southwire Incorporated.
 - 7. American Insulated Wire Corp
 - 8. Carol Cable Co., Inc
- B. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658. Refer to Part 3 of this section for allowable types specific to this project.
- C. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658. Refer to Part 3 of this section for allowable types specific to this project.

2.2 CONNECTORS AND SPLICES

- A. Acceptable Manufacturers: Subject to being equivalent and subject to compliance with requirements, provide product by one of the manufacturers listed below. If not listed, submit as substitution.
1. AFC Cable Systems, Inc.
 2. Gardner Bender.
 3. Hubbell Power Systems, Inc.
 4. Ideal Industries, Inc.
 5. Ilsco; a branch of Bardes Corporation.
 6. NSi Industries LLC.
 7. O-Z/Gedney; a brand of the EGS Electrical Group.
 8. 3M; Electrical Markets Division.
 9. Tyco Electronics.
 10. Square D, a Schnieder Electric Company
 11. Thomas & Betts
 12. Arrow-Hart Div, Crouse-Hinds Co
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.

2.3 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Provide wire, cable and connectors suitable for the temperature, conditions and location where installed.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Stranded Copper .
- B. Branch Circuits: Stranded conductors.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Provide conductor insulation rated at 600VAC and 90 degrees C.

- B. Provide THHN/THWN insulation for conductors size 500 kcmil (MCM) and larger, and for conductors # 8 AWG and smaller. Provide THW or THHN/THWN insulation for other sizes as appropriate for the locations where installed.
- C. Provide XHHW-2 insulation for wiring below grade and for wiring subject to moisture conditions.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Provide grounded (“neutral”) conductor in all lighting control device (switch, dimmer, occupancy sensor, etc.) wall outlet boxes, even if not immediately used.
- B. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- C. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- D. Use manufacturer UL approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- E. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- F. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- G. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- H. Install wire in raceway unless specifically permitted otherwise in this specification section, under other Division 26 sections, or on electrical drawings.
- I. Provide dedicated parity sized neutral conductor for each branch circuit phase conductor fed from 15 ampere and 20 ampere branch circuit breakers.
- J. Provide grounded (“neutral”) conductor for all multi-pole feeders. Provide grounded (“neutral”) conductor(s) for all multi-pole feeders and branch circuits unless this contractor determines in field that the affected load(s) will never have need for a grounded (“neutral”) conductor and NEC does not mandate otherwise.
- K. Provide grounded (“neutral”) conductor in all lighting control device (switch, dimmer, occupancy sensor, etc.) wall outlet boxes, even if not immediately used.

- L. Connect wires #6 AWG and larger to panels and apparatus by means of approved lugs or connectors large enough to enclose all strands of the conductors. Provide solderless type connectors
- M. Do not pull wire until raceways are complete, plastering is complete, and raceways are free of moisture. Install joints and splices only at NEC approved panels, accessible junction boxes, or accessible outlet boxes. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant, where necessary to prevent damage to conductors. Use pulling means, including fish tape, cable, rope, and basket weave wire/cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to wire or cable. Conceal work in finished spaces.
- N. Neatly dress work. Install work parallel and perpendicular to surfaces and exposed structural members, and follow surface contours where possible. Keep conductor splices to minimum. Install splice and tap connectors that possess equivalent, or better, mechanical strength and insulation rating than conductors being spliced. Use splice and tap connectors that are compatible with conductor material. Install wires continuous from outlet to outlet. Provide insulation value of joints at least 100 percent in excess of wire. Provide adequate length of conductors within electrical enclosures, and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than #10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at the terminal.
- O. Derate cables per NFPA 70 where bundled, where passing through insulation, and where otherwise required to be compliant with NFPA 70 based on field conditions and/or means and methods that will be used.
- P. Derate conductors per NFPA 70 where required based on quantities of conductors within raceways, and where otherwise required to be compliant with NFPA 70 based on field conditions and/or means and methods that will be used.
- Q. Provide factory splice kits (U.L. approved for submersion in water and direct burial) for wire splicing in outdoor grade, or slab on grade, junction boxes and for all other wet locations.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 8 inches of slack.

- D. Provide complete assembly of materials for each type of required electrical connection, including but not limited to, pressure connectors, terminal (lugs), electrical insulating tape, heat shrinkable insulating tubing, cable ties, solderless wire-nuts, and other items and accessories as needed to complete splices and terminations of types indicated.
- E. Unless otherwise indicated, provide wires/cables (conductors) for electrical connections that match, including sizes and ratings, of wires/cables that are supplying electrical power. Provide copper conductors with conductivity of not less than 98% at 90 degrees C.
- F. Provide electrical connectors and terminals that mate and match, including sizes and ratings, with equipment terminals, and that are recommended by equipment manufacturer for intended applications.
- G. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment. Cover splices with electrical insulating material to achieve insulation at least 100 percent in excess of electrical insulation rating of those conductors being spliced. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Do not "ring" copper conductors while skinning wire.
- H. There may be cases where circuit or feeder conductor sizes are too large or too small to fit into the lugs normally supplied with the power distribution equipment or end-use equipment, due to circumstances such as increasing conductor sizes to offset voltage drop, unusual breaker frame sizes, type of conductors used, etc. In such cases provide appropriate factory lug kits for affected equipment if recommended by manufacturer; elsewhere provide insulated butt-splices with tails sized to fit respective lugs.
- I. Ground metal frames of portable and stationary direct-wired electrically operated equipment by connecting frames to the circuit equipment grounding conductor and to grounded metal raceway. Provide necessary electrical connections between the specified equipment and junction boxes, disconnect switches, and starters near equipment with flexible metallic conduit and matched connectors. Do not expose flexible conduit in finished areas.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 CONDUCTOR SIZING

- A. Conductor sizes indicated are based on copper unless specifically indicated otherwise on single-line diagram on drawings.
- B. Provide minimum #12 AWG conductor size.
- C. Provide the following minimum wire sizes based on distances from panel to first device of a 15 or 20 ampere general lighting or receptacle branch circuit. In addition to upsizing conductors as required for voltage drop, provide minimum #10 AWG conductors to the last device for branch circuits more than 150 feet in length.

<u>Distance</u>	<u>AWG Wire Sizes</u>
Up to 60 feet	#12
61 to 90 feet	#10
91 to 150 feet	#8
151 to 240 feet	#6

- D. Provide the following minimum AWG conductor sizes for general branch circuiting that are not indicated on drawings, based on using copper conductors. Where applicable increase as required to accommodate voltage drop and to accommodate special conditions. Do not derate any grounded (neutral) conductors. Temperature ratings listed below pertain to both wire and terminations.

<u>Source Breaker/Fuse</u>	<u>AWG Wire Size</u>	<u>Eq. Grounding AWG Wire Size</u>
20 Ampere	#12	#12
25 Ampere	#10	#10
30 Ampere	#10	#10
35 Ampere	# 8	#10
40 Ampere	# 8	#10
45 Ampere	# 8	#10
50 Ampere	# 6	#10
60 Ampere	# 6	#10
70 Ampere	# 4	# 8
80 Ampere	# 4	# 8
90 Ampere	# 2	# 8
100 Ampere	# 2	# 8

3.7 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.8 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

END OF SECTION 260519

Submittal Form – 260519.00 – Low-Voltage Electrical Power Conductors And Cables

Provide And Complete This Sheet And Submit As A Cover Sheet For Submittals Requested Within This Section.

Electrical Contractor: _____ Electrical Supplier: _____

Electrical Contractor Rep: _____ Electrical Supplier Rep: _____

Electric Contractor Ph. Number: _____ Electric Supplier Ph. Number: _____

Electric Contractor Rep Email: _____ Electric Supplier Rep Email: _____

Submitted Conductor Manufacturers (List Conductor Type And Manufacturer): _____ _____		
Submitted Cable Manufacturers (List Cable Type And Manufacturer): _____ _____		
	Yes	No
Manufacturers Listed As Basis Of Design Or Listed Equivalent Manufacturers? If No, Explain _____	<input type="checkbox"/>	<input type="checkbox"/>
Manufacturers' Qualifications Meet Or Exceed Those Required Under Quality Assurance Section Within This Specification? If No, Explain _____	<input type="checkbox"/>	<input type="checkbox"/>
Manufacturers' Warranty Meets Or Exceeds The Warranty Period Specified Within This Specification? If No, Explain _____	<input type="checkbox"/>	<input type="checkbox"/>
Submitted Components Meet All Requirements Listed Within This Specification? If No, Explain _____	<input type="checkbox"/>	<input type="checkbox"/>
Type Mc Cable Includes Continuous Length Of Spirally Wound, Interlocked Zinc Coated Or Galvanized (Inside And Outside) Strip Steel? If No, Explain _____	<input type="checkbox"/>	<input type="checkbox"/>
Type Mc Cable Includes Parity-Sized Insulated Equipment Grounding Conductor? If No, Explain _____	<input type="checkbox"/>	<input type="checkbox"/>

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Grounding systems and equipment.

1.2 RELATED DOCUMENTS

- A. Division 27, Section 270526.00 "Grounding and Bonding for Communications" for communications grounding busbars and conductors.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.
- C. Comply with ANSI/TIA/EIA-607, "Commercial Building Grounding and Bonding Requirements for Telecommunications."

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Except as otherwise indicated, provide copper electrical grounding and bonding systems and materials with assembly of materials including but not limited to cables/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, and additional accessories needed for a complete installation. Where materials or components are not indicated, provide products that comply with NEC, UL, and IEEE requirements, and with established industry standards for those applications indicated. Utilize compatible metallic materials throughout system to eliminate galvanic action.

- B. Acceptable Manufacturers: Subject to being equivalent and subject to compliance with requirements, provide conductors and connectors as specified in Section 260519. Subject to being equivalent and subject to compliance with requirements, provide other grounding related materials by Erico (as a standard of quality), or other equivalent available manufacturers where not otherwise specified in Division 26.

2.2 GROUNDING BUSBARS

- A. Electrical Service Entrance grounding busbar
 - 1. Electro-tin plated ¼" thick copper bar
 - 2. Insulated standoffs
 - 3. Hole pattern type "CC"
 - 4. 4 inches high x 24 inches wide
 - 5. Standard of quality shall be equivalent to Erico Electrical Products # EGBA14424CC
- B. Telecommunications grounding busbar
 - 1. Provide telecommunications grounding busbar(s) as specified in Division 27, Section 270526.00

2.3 CONDUCTORS

- A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.

2.4 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.5 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel (copper molecularly bonded to nickel-sealed high-strength steel core); 3/4 inch in diameter by 10 feet in length. Sectional rods may be used when rods are longer than 10 feet.
- B. Copper Plates: Sheet copper plate electrodes that are 20-gage by 36" by 36", made from high-conductivity sheet, with cable attachments (minimum quantity of 2), sized for cables as necessary to fulfill project grounding requirements.

2.6 INSPECTION WELLS

- A. Provide inspection well for each connection to underground grounding electrodes.
 - 1. In paved areas provide inspection well equal to Erico Eritech Inspection Well 416D or 416F series depending on application, with the following characteristics.
 - a. Constructed of polymer concrete.
 - b. 10,000 lb. load rating.
 - c. Bolt-down cover.
 - d. Skid-resistant surface.
 - e. Gray color.
 - f. "Ground" embossed in the lid.
 - 2. In unpaved areas provide inspection well equal to Erico Eritech Inspection Well 416B or 416C series depending on application, with the following characteristics.
 - a. Constructed of high density polyethylene.
 - b. Acid and chemical resistant.
 - c. Green or black color.
 - d. "Ground" embossed in the lid.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum. Where to be installed underground, bury at least 36 inches below grade.
- C. Grounding Conductors in corrosive areas: Install tinned copper conductor, No. 2/0 AWG minimum. Where to be installed underground, bury at least 36 inches below grade.
- D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Minimum two hole bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors as required by NFPA 70 and as otherwise required. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 1. All feeders.
 2. All branch circuits.
 3. Flexible raceway runs.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Rods: Drive rods until tops are at least 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.
 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
 3. Use driving sleeves or couplings when driving ground rods into the earth.
- C. Ground Plates: Provide copper ground plates where ground rods cannot be used. Provide connections to ground electrodes at a point not less than 1 foot below grade level, and not less than 2 feet away from footings and foundations.
 1. Weld grounding conductors to underground grounding electrodes where mechanical connections cannot, or should not, be utilized.
 2. Interconnect ground plates with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.

- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
- E. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install 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; use a bolted clamp connector or bolt a lug-type connector to a pipe flange using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each above ground portion of gas piping system downstream from equipment shutoff valve.
- F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- G. Service Entrance Grounding Requirements
1. Provide a parity sized insulated grounded conductor (neutral) for each set of service entrance feeder phase/line conductors, terminated and bonded to service equipment (i.e. to each and every service disconnect where applicable). This applies whether or not downstream loads require a neutral conductor. Install these neutral conductors unspliced and unbroken.
 2. Ground and bond service entrance neutrals to room ground busbar, to effectively grounded structural steel member, to effectively grounded metallic water pipe, and to grounding electrode system as required per NFPA 70 and as applicable.
 3. Provide an enclosed single ground busbar at electrical service entrance locations, bonded to the enclosure, and bonded to service ground with full parity sized green insulated ground conductor (sized same as service ground conductor). Provide quantity and sizes of lugs on busbars as required to accommodate bonding to service grounding electrode system, service neutrals, structural steel, effectively grounded metallic water pipe, and other grounding requirements set forth in project manual and in NFPA 70. Provide UL listed lugs for use with copper and aluminum conductors.
 4. Connect grounding electrode conductors to 1-inch diameter, or greater, metallic cold water pipe at service entrance using a suitably sized ground clamp. Provide connections to flanged piping at street side of flange. Ground electrical service system neutral at service entrance equipment to grounding electrodes. Install braided type bonding jumpers

with code-sized ground clamps on water meter piping to electrically bypass water meters and water service entrance valves.

5. Contact AHJ electrical inspector in advance of installing service grounding work. Determine locally approved methods that must be used for re-bar grounding that the AHJ considers compliant with NFPA 70 Article 250.52.

H. Grounding Requirements for Additions to Existing Structures

1. Equalize (bond together) ground potentials associated with the electrical distribution system, separately derived systems, and steel structural related systems of new additions and existing structures. Bond together new structural steel (including re-bars) for full electrical continuity and for full potential equalization. Include the bonding of new structural steel to existing structural steel that is rendered accessible under this project.
2. For building additions/expansions with steel structural related systems, bond every new perimeter column to adjacent existing columns of existing structures. Provide an earth ground at every other new column in the north/south direction, and every other new column in the east/west direction. Provide a minimum surface contact area of 8 square inches, bolted or welded securely to clean areas of the steel, for structural steel bonding plates. Bond new structural steel (including re-bars) to the service entrance ground for full electrical continuity and for full potential equalization.
3. Provide a grounding electrode for each new steel column that extends down to grade level for vertical building additions/expansions that have steel structural systems. Attach ground terminals to such structural steel columns at the lowest available point.

I. Telecommunications Grounding Requirements

1. At minimum, bond together telecommunications racks, cabinets, tray, ladder rack, and risers in each telecommunications equipment room (ER) and telecommunications wiring closet/room (TR) to the busbar in the respective room. Bond each TR busbar to the ER busbar. Bond the ER busbar to the to the grounding electrode system and the electrical grounding system at the main building ground point. Bond additional points where indicated in the drawings and where required by NFPA 70. Provide a common ground with the building's grounding electrode system for the Telecommunications Infrastructure components.
2. Bond the Main telecommunication service entrances to the electrical service equipment ground using the most direct route possible to minimize conductor length.
3. Provide copper grounding conductor from main building grounding electrode system at service entrance to ground bus at the Telecommunications Entrance Facility.
4. Provide copper bus bars on plywood backboard in each ER and TR. See Division 27, Section 270526.00 for bus bar specifications.
5. Provide copper grounding conductors, in conduit, from the electric service ground busbar to each ER and TR ground busbar.
6. Provide minimum #6 AWG bonding jumper (12 inches maximum) with appropriate lugs at each cable tray joint, or provide manufactured braided copper grounding jumper equal to B-Line #CAM-GJ, T&B #BD12, OZ/Gedney type "FB", or Mono-Systems equal.
7. Provide minimum #6 AWG insulated (green insulation) grounding conductor with appropriate lugs from side of cable trays to each ER and TR ground busbar. Drill and tap side of cable trays (for appropriate size bolt, 1/4 inch by 20 min.), and provide bolted connections making sure that bolts do not extend into wire management part of trays.

8. Provide isolation for grounding busbars from the structure support with a 2 inch minimum separation using manufacturer's recommended insulating stand-offs and hardware.
9. See detail(s) on drawings.

3.4 LABELING

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for instruction signs. The label or its text shall be green.
- B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.
 1. Label Text: "GROUND SYSTEM - If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 3. 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. Make tests at ground rods before any conductors are connected.
- B. Measure and report measured ground resistances that exceed 3 ohms.
 1. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance. After review and comment by Engineer, take appropriate action to reduce resistance to specified values, by driving additional ground rods or installing additional ground plates or chemically treating adjacent soil, or providing chemical ground rods or combinations thereof. Then retest to demonstrate compliance.

END OF SECTION 260526

Submittal Form – 260526.00 – Grounding And Bonding For Electrical Systems

Provide And Complete This Sheet And Submit As A Cover Sheet For Submittals Requested Within This Section.

Electrical Contractor: _____ Electrical Supplier: _____

Electrical Contractor Rep: _____ Electrical Supplier Rep: _____

Electric Contractor Ph. Number: _____ Electric Supplier Ph. Number: _____

Electric Contractor Rep Email: _____ Electric Supplier Rep Email: _____

Submitted Manufacturers:		
Busbars: _____		
Conductors: _____		
Connectors: _____		
Electrodes: _____		
Inspection Wells: _____		
	Yes	No
Manufacturers Listed As Basis Of Design Or Listed Equivalent Manufacturers?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Manufacturers' Qualifications Meet Or Exceed Those Required Under Quality Assurance Section Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Manufacturers' Warranty Meets Or Exceeds The Warranty Period Specified Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Submitted Components Meet All Requirements Listed Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS/WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. It shall be the responsibility of the electrical contractor to supervise the installation of and pay for all additional members, wood or metal and labor which may be required to support any type of permanent or temporary electrical apparatus employed in the execution of the electrical contractor's work. Provide supports, anchors, sleeves and seals furnished as part of factory-fabricated equipment as required.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

- A. Provide supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Provide equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this project, with a minimum structural safety factor of five times the applied force.

1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Metal support systems and assemblies
 - 2. Conduit/raceway and cable support components
 - 3. Equipment supports
 - 4. Plywood equipment boards

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates upon request, if applicable.

1.7 QUALITY ASSURANCE

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

1.8 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly. Construct with 9/16" dia. holes, nominal 2" o.c. on top surface, with standard factory finish, and with the all necessary fittings which mate and match with U-channel.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Allied Tube & Conduit
 - b. Cooper B-Line, Inc.; a division of Cooper Industries
 - c. ERICO International Corporation
 - d. GS Metals Corporation
 - e. Thomas & Betts Corporation
 - f. Unistrut; Tyco International, Ltd.

- g. Wesanco, Inc.
 - h. Perma-Cote
2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 3. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
1. Riser clamps for supporting rigid metal conduit; galvanized steel; with 2 bolts and nuts, and 4" ears.
 2. Clevis hangers: For supporting rigid metal conduit; galvanized steel; with 1/2" dia. hole for round steel rod.
 3. Galvanized steel clamps; 1/2" rod size.
 4. Galvanized steel clamps, 1-1/4" x 3/16" stock; 3/8" cross bolt; flange width 2".
 5. One-hole conduit straps for supporting 3/4" rigid metal conduit; galvanized steel.
 6. Two-hole conduit straps for supporting 3/4" rigid metal conduit, galvanized steel; 3/4" strap width; and 2-1/8" between center of screw holes.
 7. Offset conduit clamps for supporting rigid metal conduit; galvanized steel.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate

for supported loads and building materials in which used. Where specified on drawings as a corrosive area, expansion anchors shall be stainless steel.

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

- 1) Cooper B-Line, Inc.; a division of Cooper Industries.
- 2) Empire Tool and Manufacturing Co., Inc.
- 3) Hilti Inc.
- 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
- 5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel galvanized springhead type, 3/16" x 4".
7. Hanger Rods: Threaded steel, Galvanized steel rods; 1/2" dia min.
8. Clevis hangers: For supporting rigid metal conduit; galvanized steel; with 1/2" dia. hole for round steel rod.
9. Galvanized steel rod reducing couplings, 1/2" x 5/8".
10. Galvanized steel clamps; 1/2" rod size.
11. Galvanized steel clamps, 1-1/4" x 3/16" stock; 3/8" cross bolt; flange width 2".
12. Hexagon nuts for 1/2" rod size; galvanized steel.
13. Lead expansion anchors, 1/2".

G. Plywood Equipment Boards: Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent. Provide plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 3/4 inches deep. Provide marine grade plywood where subject to moisture conditions. Provide Simpson Strong Tie (or equal) expansion screw anchors.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. All electrically related work shall be supported directly from building structural members. Electrically related work shall not be supported from ductwork, ductwork hangers, ceiling supports, existing conduit supports, etc.
- C. All conduits, raceways and cables (where applicable) shall be routed parallel and perpendicular to building structural members. Any and all noncompliant work installed by the electrical

contractor shall be removed and reinstalled by the electrical contractor to the satisfaction of the Owner's representative and the Engineer, at the expense of the electrical contractor.

- D. Install hangers, supports, clamps and attachments to support piping properly from building structure. Install supports with spacing's indicated and in compliance with NEC requirements. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- E. Stem lengths of all pendant fixtures shall be as directed by the owner's representative.
- F. All fasteners, hangers and method of hanging exposed work in finished areas shall be submitted to the owner's representative for review before installation. Fasteners shall be zinc-coated, type, grade, and class as required for a neat finished installation.
- G. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70 as a minimum. Minimum rod size shall be 1/4 inch in diameter.
- H. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted, sized so capacity can be increased by at least 50 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps, single-bolt conduit clamps, or single-bolt conduit clamps using spring friction action for retention in support channel as applicable.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Do not suspend overhead hangers, or support any other overhead electrical work, from roof decks.
- C. Install work so that no raceway or cable is within six inches below roof deck(s).
- D. Suspend and support overhead electrical from roof trusses and joists/joist girders only at panel points, at top cord only, unless otherwise indicated.
- E. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

- F. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
1. To Wood: Fasten with lag screws or through-bolts. Provide Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWWPA rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent. Provide marine grade products where subject to moisture conditions. Provide Simpson Strong Tie (or equal) expansion screw anchors. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor electrical materials and equipment. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members. Attach to substrates as required to support applied loads.
 2. Attachments to Wood Structural Members: Provide bolts installed through members.
 3. To New Concrete: Provide channel-type concrete inserts and bolt to inserts, or provide expansion anchors for applications where inserts are not practical.
 4. To Existing Concrete: Expansion anchor fasteners.
 5. Holes for Expansion Anchors in Concrete: Drill at locations and to depths that avoid reinforcing bars.
 6. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 7. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick. Do not use for work anchored to newly installed concrete. Only use this method where other methods cannot or should not be used, and only after receiving case-by-case permission from Owner and design professionals.
 8. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, or beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69, clamped to flanges of beams or on upper truss chords of bar joists.
 9. To Light Steel: Sheet metal screws.
 10. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- G. Install work so that no raceway or cable is within six inches below roof deck(s).
- H. Coordinate all work with all other trades prior to commencement of the work.
- I. Layout and install all electrical work in strict compliance with Chapter 1, Part B, Section 110.26 of the latest adopted edition of NFPA 70. Locations and routing that may be shown on plans are schematic and diagrammatic in nature.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 ELECTRICAL EQUIPMENT ANCHORAGE

- A. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- B. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
- D. Provide female expansion anchors, and install studs and nuts after equipment is positioned.
- E. Bushings for Floor-Mounted Equipment Anchors: Provide to allow for resilient media between anchor bolts/studs and mounting hole in concrete.
- F. Anchor Bolt Bushing Assemblies for Wall-Mounted Equipment: Provide to allow for resilient media where equipment and equipment-mounting channels are attached to wall.
- G. Torque bolts and nuts on studs to values recommended by equipment manufacturer.
- H. Size and provide concrete bases so expansion anchors will be a minimum of 10 bolt diameters from the edge of the concrete base.

3.5 PAINTING

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

3.6 PLYWOOD EQUIPMENT BOARDS

- A. Unless otherwise noted, boards shall be painted with two coats of good grade weatherproof flat gray non-conductive fire-retardant paint on all sides and edges (prior to mounting) and plumbed in a true vertical position. Provide nominal 1/2" rustproof spacers between back of plywood and wall.
- B. Cut, fit, and place plywood equipment boards accurately in location, alignment, and elevation to support and anchor electrical materials and equipment. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members. Attach to substrates as required to support applied loads. Maintain at least 4 inches from bottom of plywood equipment boards and the finished floor surface.
- C. Unless directed otherwise in field, plywood equipment boards shall be 8 feet high by 3/4 inches deep by length shown on drawings (as dimensioned or as scaled) or length as required to accommodate equipment if not indicated on drawings.
- D. Provide plywood equipment boards at locations as shown on drawings.
- E. Unless directed otherwise in field, plywood equipment boards shall be provided for all surface mounted panelboards and systems "head-end" equipment for all applications where located in mechanical or electrical rooms and only where specifically shown on drawings for all other applications.

END OF SECTION 260529

Submittal Form – 260529.00 – Hangers And Supports For Electrical Systems

Provide And Complete This Sheet And Submit As A Cover Sheet For Submittals Requested Within This Section.

Electrical Contractor: _____ Electrical Supplier: _____

Electrical Contractor Rep: _____ Electrical Supplier Rep: _____

Electric Contractor Ph. Number: _____ Electric Supplier Ph. Number: _____

Electric Contractor Rep Email: _____ Electric Supplier Rep Email: _____

Submitted Manufacturers:		
Metal Support Systems And Assemblies: _____		
Conduit/Raceway/Cable Support Components: _____		
Equipment Supports: _____		
Plywood Equipment Boards: _____		
	Yes	No
Manufacturers Listed As Basis Of Design Or Listed Equivalent Manufacturers?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Manufacturers' Qualifications Meet Or Exceed Those Required Under Quality Assurance Section Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Manufacturers' Warranty Meets Or Exceeds The Warranty Period Specified Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Submitted Components Meet All Requirements Listed Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

- B. Related Requirements:

1. Section 26 05 53.00 "Identification for Electrical Systems" for raceway related identification requirements.

1.3 DEFINITIONS

- A. EMT: Electric metallic tubing.
- B. FMC: Flexible metallic conduit.
- C. GRC: Galvanized rigid steel conduit.
- D. IMC: Intermediate metal conduit.
- E. LFMC: Liquid-tight flexible metallic conduit.
- F. RNC: Rigid nonmetallic conduit.
- G. Types of electrical boxes and fittings specified in this section include the following:
 1. Outlet boxes.
 2. Junction boxes.

3. Pull boxes.
4. Bushings.
5. Locknuts.
6. Knockout closures.

1.4 ACTION SUBMITTALS

- A. Refer to Section 260503, Submittals for Electrical Systems.
- B. Product Data: For surface raceways, wireways and fittings, boxes, hinged-cover enclosures, and cabinets.
- C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.
- D. Samples: For wireways, nonmetallic wireways, and surface raceways and for each color and texture specified, 12 inches long. Furnish samples if requested by Owner's representative.

1.5 INFORMATIONAL SUBMITTALS

- A. Refer to Section 260503, Submittals for Electrical Systems.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. AFC Cable Systems, Inc.
 2. Allied Tube & Conduit; a Tyco International Ltd. Co.
 3. Anamet Electrical, Inc.
 4. Electri-Flex Company.
 5. O-Z/Gedney; a brand of EGS Electrical Group.
 6. Picoma Industries, a subsidiary of Mueller Water Products, Inc.
 7. Republic Conduit.
 8. Robroy Industries.
 9. Southwire Company.
 10. Thomas & Betts Corporation.
 11. Western Tube and Conduit Corporation.
 12. Wheatland Tube Company; a division of John Maneely Company.
 13. Steel city.
 14. Regal.
 15. Efcor.
 16. LTV.

17. Carlon.
 18. Cantex.
 19. Walker/Wiremold.
- B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering interior outlet box products that may be incorporated into the Work include, but are not limited to, the following:
1. Adalet.
 2. Appleton Electric.
 3. Bell Electric.
 4. Bowers.
 5. Eagle Electric Mfg Co., Inc.
 6. Midland-Ross Corp.
 7. OZ/Gedney.
 8. Pass and Seymour, Inc.
 9. RACO.
 10. Hubbell.
 11. Thomas & Betts Co.
 12. Thepitt.
- C. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. GRC: Comply with ANSI C80.1 and UL 6.
1. Provide zinc coating fused to inside and outside walls of conduit.
- E. IMC: Comply with ANSI C80.6 and UL 1242.
- F. EMT: Comply with FS WW-C-563, ANSI C80.3 and UL 797.
- FMC: Comply with FS WW-C-566 and UL 1; zinc-coated steel .
1. Provide flexible metal conduit formed from continuous length of spirally wound, interlocked zinc-coated or galvanized (inside & outside) strip steel. Provide conduit fittings for use with flexible steel conduit of threadless hinged clamp type, with insulated throats. Provide Straight Terminal Connectors consisting of one piece body, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end with locknut. Do not use 45 degree or 90 degree Terminal Angle Connectors for flexible or water-tight flexible metal conduit in locations that will not be fully accessible after completion of construction. Provide full size green insulated ground wire for all applications, regardless of length.
- G. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

1. Provide liquid-tight flexible metal conduit formed from continuous length of spirally wound, interlocked, double-wrapped galvanized (inside & outside) strip steel. Provide liquid-tight jacket of flexible polyvinyl chloride (PVC). Provide smooth-wall type jackets (not a corrugated look) for finished area furniture whip (and similar) applications. Provide Liquid-Tight Flexible Metal Conduit Fittings compliant with FS W-F-406, Type 1, Class 3, Style G. Provide cadmium plated, malleable iron fittings with compression type steel ferrule and neoprene gasket sealing rings, with insulated throat. Provide Straight Terminal Connectors that are one piece body, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end with locknut. Provide Terminal Angle Connectors that are 45 degree or 90 degree two-piece body construction with removable upper section, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut. Do not use 45 degree or 90 degree Terminal Angle Connectors for flexible or water-tight flexible metal conduit in locations that will not be fully accessible after completion of construction. Provide full size green insulated ground wire for all applications, regardless of length.
- H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
1. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Compression.
 - c. Note: Provide galvanized or zinc-coated concrete-tight fittings. Do not use die-cast fittings.
 2. Fittings for GRC:
 - a. Material: Steel.
 - b. Type: Threaded (galvanized or zinc coated after threading.)
 3. Expansion Fittings: Material to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
 4. Provide terminal conduit fittings with insulated throats, or plastic bushings for conduits 2" and larger where insulated throats may not be readily available.
 5. Provide locknuts for securing conduit to metal enclosure with sharp edge for digging into metal, and ridged outside circumference for proper fastening. Provide screw type grounding terminal for metal bushings of standard or insulated type.
 6. Provide miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings, and plugs that are specifically designed for their particular application.
 7. Provide galvanized cast-metal (steel) conduit bodies of types, shapes and sizes as required to fulfill job requirements and NFPA 70 requirements. Construct conduit bodies with threaded-conduit-entrance ends, with removable covers, either cast or of galvanized steel, and with corrosion-resistant screws.
- I. Joint Compound for Threaded Conduit: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Cooper B-Line, Inc.
 2. Hoffman; a Pentair company.
 3. Mono-Systems, Inc.
 4. Square D; a brand of Schneider Electric.
 5. Steel city.
 6. T&B.
 7. Regal.
 8. Efcor
 9. Wheatland.
 10. Allied.
 11. LTV.
 12. Carlon.
 13. Cantex.
 14. Walker/Wiremold.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 for indoor applications and Type 3R for outdoor applications unless otherwise indicated, and sized according to NFPA 70.
1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Provide electrical wireways of types, grades, sizes, and number of channels for each type of applicable service.
 3. Provide lay-in wireways with hinged covers in accordance with UL 870, and with components UL-listed, including lengths, connectors, and fittings. Provide units that allow fastening of hinged cover closed without use of parts other than standard lengths, fittings and connectors. Provide units capable of sealing cover in closed position with sealing wire. Provide wireways with knockouts.
 4. Provide wireway connectors suitable for "lay-in" conductors, with connector covers permanently attached so that removal is not necessary to utilize the lay-in feature. Provide NEMA 3R units where used outdoors or in areas subject to moisture.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Screw-cover type for indoor applications and Flanged-and-gasketed type for outdoor applications unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish. Protect sheet metal parts with rust inhibiting coating and baked enamel finish. Provide plate-finished hardware to prevent corrosion. Protect screws installed toward inside of wireway, with spring nuts to prevent wire insulation damage.

2.3 SURFACE RACEWAYS

- A. **There shall be no surface raceway on this project.**

- B. **All new conduits in finished areas shall be installed concealed in walls, floors or above ceilings. Solid walls, such as concrete, shall be channeled to accept new conduit and outlet boxes and then patched to match the existing surfaces as closely as possible. When wall covering is present, cut and peel back wall covering prior to channeling. After patching is completed, attach wall covering with adhesive and brush or roll down.**

2.4 BOXES, ENCLOSURES, AND CABINETS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Adalet
 - 2. Cooper Technologies Company; Cooper Crouse-Hinds
 - 3. EGS/Appleton Electric
 - 4. Erickson Electrical Equipment Company
 - 5. FSR Inc.
 - 6. General Electric Company
 - 7. Hoffman; a Pentair company
 - 8. Hubbell Incorporated; Killark Division
 - 9. Kraloy
 - 10. Milbank Manufacturing Co.
 - 11. Mono-Systems, Inc.
 - 12. O-Z/Gedney; a brand of EGS Electrical Group
 - 13. RACO; a Hubbell Company
 - 14. Robroy Industries
 - 15. Siemens/ITE
 - 16. Spring City Electrical Manufacturing Company
 - 17. Square D Company
 - 18. Stahlin Non-Metallic Enclosures; a division of Robroy Industries
 - 19. Tay-Mac
 - 20. Thomas & Betts Corporation
 - 21. Westinghouse/Cutler-Hammer
 - 22. Wiremold / Legrand

- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
 - 1. Provide galvanized-coated flat rolled code-gage non-gangable sheet-steel outlet/junction/pull boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations.

2. Construct outlet boxes with mounting holes and with cable and conduit-size knockout openings in bottom and sides where applicable. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding.
 3. Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps, and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations. Provide with stainless steel nuts, bolts, screws and washers.
 4. **Outlet boxes for switches, receptacles and telephone and/or data circuits shall be 4 11/16 inches square by 2 1/8 inches deep with extension rings. Outlet boxes in masonry walls shall be masonry type.**
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
- I. Box extensions used to accommodate new building finishes shall be of same material as recessed box and shall extend to the finished wall surface.
- J. Bushings, knockout closures and locknuts:
1. Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications.
- K. Device Box Dimensions: 4 inches square by 1-1/2 inches deep or 4 inches square by 2-1/8 inches deep, depending on device depths and wiring fill, with single-gang plaster/"mud" rings where only one device is being installed. Provide wider boxes for applications where more than two devices will be installed. Provide internal metal dividers where required under NFPA 70 for varying voltages, multiple circuits, etc..
- L. Gangable boxes (using multiple single-gang boxes to assemble multi-gang boxes) are prohibited.

- M. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 for indoor applications and Type 3R for outdoor applications with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- N. Weathertight outlet boxes and covers:
1. Provide corrosion-resistant weathertight/raintight outlet wiring boxes, of types, shapes and sizes, including depth of boxes, with threaded conduit holes for fastening electrical conduit, suitably configured for each application, including face plate gaskets and corrosion-resistant plugs and fasteners. Provide weathertight outlets for interior and exterior locations exposed to weather or moisture.
 2. Provide weatherproof covers that mount on a single gang horizontal or vertical (depending on application) junction box to ensure weather protection for a standard outlet. Provide covers that can mount on indoor or outdoor junction boxes and that include a weatherproof cover/base assembly with gasket, two universal inserts, and mounting hardware. Provide weatherproof cover that provides flexibility in installation. Provide covers that meet or exceed UL requirements for wet locations while in use, that meet requirements of NFPA 70 Article 410-57(b), and are NEMA 3R rated. Provide weatherproof cover constructed of UV stabilized high impact polycarbonate material. Provide clear cover for the part that encloses the cord set, to allow visual inspection. Provide cover that meets agency requirements for cold impact at negative 60 degrees Fahrenheit (negative 51 degrees C). Provide covers with useable inside depth to accommodate plug head. Provide assemblies for outdoor applications, unless indicated otherwise on drawings, and for indoor applications that serve permanent or extended-use cord & plug load connected equipment.
 3. Provide minimal profile assemblies that rated NEMA 3R While In Use and that employ recessed box and cover design, equal to Thomas & Betts "Red Dot" series. Provide trim color(s) as directed by Architect.
 4. Where shown indoor at switches or outlets to provide visual deterrence from being used by unauthorized personnel, provide conventional cast aluminum or cast zinc cover plate units and paint to match surrounding wall surfaces.
- O. Cabinets:
1. NEMA 250, Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 2. Hinged door in front cover with flush latch and concealed hinge.
 3. Key latch to match panelboards.
 4. Metal barriers to separate wiring of different systems and voltage.
 5. Accessory feet where required for freestanding equipment.
 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: GRC or IMC
2. Concealed Conduit, Above ground in Dry and Noncorrosive Locations Not Subject to Physical Damage: EMT.
3. Concealed Conduit, Aboveground in Damp Locations, Wet Locations, Corrosive Locations, Where Not Subject to Physical Damage: IMC.
4. Concealed Conduit, Aboveground in Damp Locations, Wet Locations, Corrosive Locations, Where Subject to Physical Damage: GRC.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
6. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R .

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed and Subject to Minor Physical Damage: EMT .
3. Concealed in Cavities of Ceilings and Interior Walls and Partitions: EMT.
4. Above-Grade Damp or Wet Locations: GRC or IMC.
5. Embedded in Concrete or Masonry: GRC.
6. Final 72 inches from accessible outlet/junction boxes to recessed luminaires that are located in accessible ceiling systems: FMC. Type AC/MC cable may be used for such "whips"; refer to Section 260519.
7. Final 24-72 Inches at Connections to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp, wet or otherwise corrosive locations (Leave sufficient slack in flexible conduit to permit movement from vibration without adversely affecting conduits and connections.)
8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

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

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. EMT: Comply with NEMA FB 2.10.
3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

3.2 INSTALLATION

A. General Installation.

1. Minimum Raceway Size: 3/4-inch trade size.
2. Locate junction and pull boxes so they remain accessible after all construction work is complete. Coordinate all work with all other trades prior to commencement of the work.
3. Layout and install all electrical work in strict compliance with Chapter 1, Part B, Section 110.26 of the latest adopted edition of NFPA 70. Locations and routing that may be shown on plans are schematic and diagrammatic in nature.
4. Layout all proposed raceway routing, elevations, installation methods, etc. on coordination drawings and coordinate all proposed raceway routing with all affected trades prior to commencing with work. In addition review the information with Owner and design professionals for all areas where the raceways will be visible after completion of construction, to ensure a neatly organized installation occurs. Where raceways must be exposed in finished areas install them in a manner that minimizes detrimental effects on room aesthetics. Install so raceways are as out of site as reasonably possible. For instance, where applicable and if so directed by the design professionals or the Owner, make drops near corners, window casings, door casings, etc. Likewise if a receptacle needs to be installed at the center of a wall, install the raceway down the wall in a corner of the room then transition and run horizontally to the outlet location if so directed by the Architect or the Owner. Use compression fittings for EMT applications in these areas. Do not use strut or fasteners that stand off from wall for wall applications in these areas. Install exposed wall-mounted conduits tight to wall using one-hole straps for conduits 1-1/4 inches and smaller, and use two-hole straps for conduits 1-1/2 inches and larger.
5. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
6. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
7. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.
8. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter.
9. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
10. Do not use access doors unless special prior written permission is granted from the owner' representative. Install pull boxes, junction boxes, etc. in areas that are accessible after construction. Do not install pull boxes or junction boxes above gypsum board, plaster or similar ceiling systems, nor above ductwork or equipment that renders them inaccessible.
11. Provide knockout closures to cap unused knockout holes where blanks have been removed.
12. Install electrical boxes in those locations that ensure accessibility to enclosed electrical wiring.
13. Do not install boxes back-to-back in walls. Provide not less than 6" (150 mm) separation in general, not less than 16" separation for acoustically rated walls and not less than 24" separation for the following applications: fire walls, fire barriers, smoke barrier walls, and fire partitions. Where outlet boxes are shown back-to-back on common walls, offset accordingly when installed.
14. Neatly cut openings for boxes so that standard size (not "midway" or "jumbo") cover plates will cover all parts of the opening.
15. Position recessed outlet boxes accurately to allow for surface finish thickness. Do not use round boxes.
16. Fasten electrical boxes firmly and rigidly to substrates and structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry as applicable. Provide box supports that are independent of conduit. Refer to Sections 260529 for further

- supporting requirements. Protect boxes from construction debris and damage subsequent to installation of boxes.
17. Consider the outlet, junction, and pull box locations indicated on drawings approximate. Study the general construction with relation to spaces and equipment surrounding each outlet, and neatly install outlets accordingly.
 18. Record junction and pull boxes on record drawings. Permanently mark and label (using methods approved by owner's representative) junction/pullboxes as to which types of electrical services are within. Refer to Section 260502 for further related requirements.
 19. Install wiring for different power voltages in raceway systems separate from each other.
 20. Install wiring for the various electrical systems in raceway systems that are separate from each other.
 21. Install wire in raceway/conduit (sized per NFPA 70) unless specifically permitted otherwise elsewhere in Division 26 sections, or on drawings.
 22. Do not install or embed conduits within slabs .
 23. Provide steel conduit and steel fittings for indoor above-slab applications, as specified in this section.
 24. Provide conduit fittings with insulated throats. Plastic bushings may be used for conduits 2" and larger where insulated throats may not be readily available.
 25. Provide pullboxes for conduit runs exceeding 100 feet in length, or having in excess of 270 degrees of offset.
 26. Provide maximum of 40 percent fill for raceways, or a threshold of less if required by NFPA 70.
 27. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above liquid and steam piping. Level and square raceway runs, and install at proper elevations and heights.
 28. Do not begin installation of conductors and cables until electrical raceways are complete and until installation locations (end to end) are in a weatherproof environment.
 29. Clean inside of conduit before wiring is pulled. Cap and plug conduit ends with standard accessories as soon as conduit has been permanently installed.
 30. Comply with requirements in Section 260529 for hangers and supports.
 31. Arrange stub-ups so curved portions of bends are not visible above finished grade or slab.
 32. Install no more than the equivalent of three 90-degree bends in any conduit run. Support within 12 inches of changes in direction.
 33. Conceal conduit and tubing within finished walls, ceilings, and floor cavities unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
 34. Support conduit within 12 inches of enclosures to which attached. Properly support and anchor raceways for their entire length using structural materials. Do not span any space unsupported.
 35. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
 36. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits. Fasten conduit terminations in sheet metal enclosures with two locknuts. Install locknuts inside and outside enclosure.
 37. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

38. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
39. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Cut conduits straight, properly ream, and cut threads for heavy wall conduit deep and clean. Field-bend conduits with benders designed for purpose so as not to distort, nor vary, internal diameters. Bring joints to a shoulder. Provide suitable supports and fasteners for conduit.
40. Install exposed conduit parallel to walls, and plumb on walls. Secure to walls and ceiling with pipe straps at intervals not exceeding six feet. Support conduit by approved straps, fasteners and hangers. Provide hangers suspended from rods. Do not use perforated strap.
41. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use, using properly selected and attached manufactured cap (tape of any sort is not permissible).
42. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
43. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated. In cases where using center of box for measurement would result in a switch-height device having an operable component higher than 48 inches above finished floor, install boxes lower as needed so that uppermost part of operable component is no higher than 48 inches.
44. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
45. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel. Coordinate all such separations with Architect in advance to ensure boxes are located properly for each application.
46. Locate boxes so that cover or plate will not span different building finishes.
47. Support boxes from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
48. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
49. Provide properly wired electrical connections within enclosures. Anchor enclosures ensuring that they are level, and permanently and mechanically secure.
50. Provide conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) for applications as needed to render electrical work fully operational.
51. Mechanically fasten together metal conduits, enclosures, and raceways to form continuous electrically conducting equipment grounding path. Connect to electrical boxes, fittings and cabinets to provide electrical continuity and firm mechanical assembly. Conduit shall be continuous between outlets to make a complete installation and to provide a continuous ground.

52. Do not use dissimilar metals throughout the systems to eliminate possibility of electrolysis. Where dissimilar metals will be unavoidably in contact, coat surfaces with corrosion inhibiting compound before assembling.
 53. Use rough-in dimensions of electrically operated equipment furnished by equipment installer. Install conduit and boxes for connection to equipment only after reviewing respective equipment and clearance dimensions, and after coordinating with other trades.
 54. Do not use electrical "handy" boxes with surface raceway installations.
 55. Do not cross shafts, or ventilating duct openings, with raceways. Keep raceways a minimum distance of 12" from parallel runs of flues, hot water pipes or other sources of heat. Support risers at each floor level with suitable hangers.
 56. Do not use running threads at conduit joints and terminations - use 3-piece union, or split coupling.
 57. Provide joints made tight with water-tight couplings matching conduit. Install corners with long radius sweep bends, except conduit sizes 1 inch and over where standard elbows may be used.
 58. Provide fasteners that are lead expansion shields in block and concrete, toggle bolts in hollow walls, machine screws on metal surfaces, and wood screws on wood construction.
 59. Provide sleeves in member for conduits passing through structural members.
 60. Where moisture conditions within conduits are encountered above grade, drill a hole at the lowest point in the conduit run so that drainage will not interfere with conditions below.
 61. Where conduit is capped at wall for future additions, do not extend more than threads-length past wall (maximum of 3/4 inch past wall for EMT).
 62. Install exposed conduits and extensions from concealed conduit systems neatly, parallel with, or at right angles to, walls of building.
 63. Install exposed conduit work so there is no interference with ceiling inserts, lights, or ventilation ducts or outlets.
 64. Where conduits for outlets on waterproof walls must be installed exposed, set anchors for supporting conduit on waterproof wall in waterproof cement.
 65. Requirements for exposed conduits also apply to conduits installed in space above hung ceilings, and in crawl spaces.
 66. Provide a 4 inch reinforced casing of concrete (3000-PSI minimum) around conduits that are installed in cinders or cinder concrete, to protect them.
 67. Install raceways concealed, except in unfinished electrical and mechanical type rooms where raceways may be exposed.
- B. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- C. Stub-ups To Above Accessible Ceilings (TAAC):
1. Use EMT, IMC, or RMC for raceways.
 2. Provide sweep bends and drag line for each application.
 3. Use a conduit bushing or insulated-throat fitting to terminate stub-ups.
 4. Extend conduits to joist space above an accessible ceiling system.
 5. Permanently identify the purpose of the conduit stub at the end of the conduit above the ceiling.

- D. Seals for Common Conduit and Raceways in Dissimilar Environments: Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service raceway enters a building or structure.
 3. Where otherwise required by NFPA 70.
- E. Insulation for Common Conduit and Raceways in Dissimilar Environments: Provide insulation on the exterior of conduit on the warm side of penetrations between dissimilar environments to prevent condensation from forming. Insulate with 1.5-inch polyisocyanurate closed cell pipe insulation with an overall PVC jacket for a minimum distance of 48" from the penetration. Applications include, but are not limited to, the following:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where otherwise required by NFPA 70.
- F. Expansion-Joint Fittings:
1. Provide expansion fittings at all locations where conduits cross building or structure expansion joints, wherever deflection is expected and as otherwise required to accommodate similar movement.
 2. Provide expansion fittings with ground bonding jumpers that are long enough to accommodate respective expansions and movement.
 3. Install in each run of aboveground EMT, GRC and IMC conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
 4. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- G. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semi-recessed luminaires, for equipment subject to vibration, noise transmission, or movement, and for transformers and motors. Use LFMC in damp or wet locations.

3.3 INSTALLATION OF EXPOSED CONDUIT OUTDOORS

- A. Only install conduit exposed outdoors when it is impossible to do otherwise, or only if specifically indicated for such installation case-by-case elsewhere in documents. Installation convenience, financial considerations, lack of coordination with other trades and similar rationale are not sufficient reasons for doing so. In cases where conduits must be installed at outdoor locations, de-rate conductors and modify conduit sizes per NFPA 70 (National

Electrical Code, NEC). Provide expansion fittings, which are UL listed and labeled for the respective applications, at all building expansion joints and at maximum distances of 100 feet. Paint all such conduits with at least two coats of UV-resistant weatherproof paint. Provide colors to match respective surrounding surfaces; submit colors to Architect for review in advance of procuring paint.

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies, at penetrations of abutted perimeter walls for building expansions/additions, and where expansion joints are used at walls. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.5 FIRESTOPPING

- A. Fire walls, fire barriers, smoke barrier walls and fire partitions:
 - 1. Steel outlet boxes that do not exceed 16 square inches in area may be used in fire walls, fire barriers, smoke barrier walls, and fire partitions only if the total area of such openings does not exceed 100 square inches for any 100 square feet of wall area. Verify with local authorities having jurisdiction prior to commencing with related rough-in work.
 - 2. Provide a minimum of 24 inches of separation between outlet boxes on opposite sides of a common wall.
 - 3. Provide outlet boxes, equipment back-boxes, etc. in fire walls, fire barriers, smoke barrier walls, and fire partitions that are of the type tested for use in fire-resistance-rated assemblies. Install in accordance with the tested assembly, and with the instructions included in the listing.
- B. Install firestopping at penetrations of fire-rated floor and wall assemblies. Refer to Section 260502 "Common Electric Materials and Methods".

3.6 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION 260533

Submittal Form – 260533.00 – Raceways And Boxes For Electrical Systems

Provide And Complete This Sheet And Submit As A Cover Sheet For Submittals Requested Within This Section.

Electrical Contractor: _____ Electrical Supplier: _____

Electrical Contractor Rep: _____ Electrical Supplier Rep: _____

Electric Contractor Ph. Number: _____ Electric Supplier Ph. Number: _____

Electric Contractor Rep Email: _____ Electric Supplier Rep Email: _____

Submitted Raceway Manufacturers (List Conduit/Raceway Type And Manufacturer): _____ _____		
Submitted Box Manufacturers (List Box Type And Manufacturer): _____ _____		
	Yes	No
Manufacturers Listed As Basis Of Design Or Listed Equivalent Manufacturers? If No, Explain _____	<input type="checkbox"/>	<input type="checkbox"/>
Manufacturers' Qualifications Meet Or Exceed Those Required Under Quality Assurance Section Within This Specification? If No, Explain _____	<input type="checkbox"/>	<input type="checkbox"/>
Manufacturers' Warranty Meets Or Exceeds The Warranty Period Specified Within This Specification? If No, Explain _____	<input type="checkbox"/>	<input type="checkbox"/>
Submitted Components Meet All Requirements Listed Within This Specification? If No, Explain _____	<input type="checkbox"/>	<input type="checkbox"/>
Will Rnc Conduits Rising From Below Grade/Slab-On-Grade Be Transitioned To Grc Conduits As Specified? If No, Explain _____	<input type="checkbox"/>	<input type="checkbox"/>
Confirm Yes That No Conduits Will Be Embedded In Or "Scatched-In" Just Below Slabs. If No, Explain _____	<input type="checkbox"/>	<input type="checkbox"/>

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Identification for raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Underground-line warning tape.
 - 5. Warning labels and signs.
 - 6. Instruction signs.
 - 7. Equipment identification labels.
 - 8. Miscellaneous identification products.

1.3 ACTION SUBMITTALS

- A. Refer to Section 260503, Submittals for Electrical Systems.
- B. Product Data: For each electrical identification product indicated.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage.
- C. Vinyl Labels for Raceways Carrying Circuits at 600 V or Less
 - 1. Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.
- D. Vinyl Labels for Empty "Spare" conduits
 - 1. Provide labels with description of purpose, and location of opposite end, on each end of conduits provided for future.

2.2 CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.
- B. Self-Adhesive, Self-Laminating Polyester Labels: Preprinted, 3-mil thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-

laminating, protective shield over the legend. Labels sized to fit the cable diameter such that the clear shield overlaps the entire printed legend.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide (where permitted by NEC for large feeder and sub-feeder conductors).
- B. Self-Adhesive, Self-Laminating Polyester Labels: Preprinted, 3-mil thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-laminating, protective shield over the legend. Labels sized to fit the conductor diameter such that the clear shield overlaps the entire printed legend.

2.4 FLOOR MARKING TAPE

- A. 2-inch wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

2.5 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning for 0-150 volts to ground equipment: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.6 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. Black letters on a white background for normal applications. Minimum letter height shall be 3/8 inch.
- B. Provide white letters on a black background for normal power distribution system equipment.
- C. Provide 1/16" thickness for units up to 20 sq. in. or 8" length; provide 1/8" thickness for larger units.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. All equipment & system identification nomenclature shown on drawings and listed herein is shown for general design and installation reference only. Field-verify the actual nameplate, etc. nomenclature prior to fabrication. Prepare record documents accordingly. Unless determined otherwise in field, provide text matching terminology and numbering of the contract documents and submittals.
- C. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- D. No labeling is required for raceways with readily identifiable terminations within the same room.
- E. In accessible ceiling spaces and exposed in unfinished areas, label conduit with panel and circuit numbers of conductors routed through the conduit. Label conduit at all wall penetrations and connections to all panels, junction boxes, and equipment served.
- F. Apply identification devices to surfaces that require finish after finish work is complete.
- G. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

- H. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- I. Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape with adhesive appropriate to the location and substrate.
- J. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- K. Cable Ties: For attaching tags. Cut off excess lengths after installing ties. Use general-purpose type, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. Indoors: Plenum rated.

3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Metal-Clad Cables, 600 V or Less: Identify with self-adhesive vinyl label. Locate at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas. Do not install in finished occupied areas.
- B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. Power
- C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in pull and junction boxes, and handholes, use color-coding to identify the phase. Color shall be factory applied to conductor insulation or field applied for sizes No. 4 AWG and larger, if authorities having jurisdiction permit. These colors apply for factory-assembled cables as well as for individual insulated conductors.
 - 1. Color-Coding for Phase Identification, 600 V or Less: Use colors listed below for conductors.
 - a. Colors for 208/120-V Circuits:
 - 1) Phase A: Black
 - 2) Phase B: Red
 - 3) Phase C: Blue
 - 4) Neutral: White
 - b. Color for Equipment Grounding:
 - 1) Green

- c. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

- D. Conductor and Cable Supplemental Identification in Damp Locations, Wet Locations and Below Grade, 600 V or less: Use metal tags. Provide correct identification on conductors and cables installed in manholes, grade mounted junction boxes, handholes, and similar damp and wet locations. Provide tag in each location with not less than two tags per cable, one near each conduit/duct through which the cable enters and leaves the hole. Attach tags immediately after cable is installed. Mark the tags to contain an abbreviation of the name of the system/facility served by the cable. Field verify identification nomenclature prior to fabrication of tags. Attach tags in strict accordance with manufacturer's recommendations. The identification described below is shown for schematic purposes only.
 - a. "P" Power
 - b. "T" Telephone
 - c. "C" Control
 - d. "F" Fire Alarm
 - e. "IT" Communication and Information Technology
 - f. "A,B,C,N" Phases and Neutral

- E. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

- F. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive, self-laminating polyester labels or self-adhesive vinyl labels with the conductor or cable designation, origin, and destination.

- G. Control-Circuit Conductor Termination Identification: For identification at terminations provide heat-shrink preprinted tubes, or self-adhesive, self-laminating polyester labels or self-adhesive vinyl labels with the conductor designation.

- H. Conductors to Be Extended in the Future: Attach write-on tags or marker tape to conductors and list source.

- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

- J. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
1. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- K. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished occupied spaces.
- L. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
1. Comply with 29 CFR 1910.145.
 2. Identify system voltage with black letters on an orange background.
 3. Apply to exterior of door, cover, or other access.
 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
 - c. Other equipment and components with multiple power or control sources.
- M. Operating and Warning Instruction Signs: Provide pre-manufactured operating and warning signage if indicated on drawings and where required by NEC or local authority having jurisdiction. Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- N. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
 - a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label for normal conditioned areas, and mechanically-fastened engraved, laminated acrylic or melamine label for areas with adverse environments (unconditioned, high humidity, detrimental vapors, etc.). Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where two lines of text are required, use labels 2 inches high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label, mechanically fastened.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

- d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure. Secure to substrate with stainless steel fasteners on main switchboards and switchgear and in locations where adhesives cannot be expected to work long-term due to environmental conditions
2. Equipment to Be Labeled: (Project may not include all pieces of equipment.)
 - a. Panelboards (also including typewritten directory of circuits in the location provided by panelboard manufacturer).
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Switchgear (also include descriptive labels for each section, switch, overcurrent protection device, etc.).
 - e. Switchboards (also include descriptive labels for each section, switch, overcurrent protection device, etc.; additionally include name of engineering firm, name of installing contractor and year of installation for service-entrance switchboards).
 - f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - g. Substations (also include descriptive labels for each section, switch, overcurrent protection device, etc.).
 - h. Emergency system boxes and enclosures.
 - i. Motor-control centers (also include descriptive labels for each section, switch, overcurrent protection device, etc.).
 - j. Enclosed switches.
 - k. Enclosed circuit breakers.
 - l. Enclosed controllers/starters.
 - m. Variable-speed controllers.
 - n. Push-button stations.
 - o. Power transfer equipment.
 - p. Contactors.
 - q. Remote-controlled switches, dimmer modules, and control devices, via engraved wall plates.
 - r. Miscellaneous Control Stations.
 - s. Battery-inverter units.
 - t. Battery racks.
 - u. Power-generating units (also include descriptive labels for each output overcurrent protection device, etc.).
 - v. Frequency changers.
 - w. Monitoring and control equipment.
 - x. UPS equipment (also include descriptive labels for each major component section, switch, overcurrent protective device, etc. if not provided by factory).
 - y. Other similar equipment designated by owner's representative, architect or engineer in field.

END OF SECTION 260553

Submittal Form - 260553.00 – Identification For Electrical Systems

Provide And Complete This Sheet And Submit As A Cover Sheet For Submittals Requested Within This Section.

Electrical Contractor: _____ Electrical Supplier: _____

Electrical Contractor Rep.: _____ Electrical Supplier Rep.: _____

Electric Contractor Ph. Number: _____ Electric Supplier Ph. Number: _____

Electric Contractor Rep. Email: _____ Electric Supplier Rep. Email: _____

	Yes	No
Are Identification Products And Installation Methods Included For Raceways?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Are Identification Products And Installation Methods Included For Conductors & Cables?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Are Identification Products And Installation Methods Included For Equipment Identification Labels?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Are Identification Products And Installation Methods Included For Other Applicable Identification Products And Methods?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Is Identification Schedule Included?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Submitted Information Meets All Requirements Listed Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		

SECTION 260584 - MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including the following apply to this section:
 - 1. General and Supplementary Conditions
 - 2. Division 01 Specification Sections
 - 3. Division 21 Specification Sections
 - 4. Division 22 Specification Sections
 - 5. Division 23 Specification Sections

1.2 SUMMARY

- A. Section Includes:
 - 1. Supplemental information related to electrical work associated with mechanical equipment and other equipment furnished and/or installed under all other divisions or by others.

1.3 ACTION SUBMITTALS

- A. No submittal actions are required under this specification section. Refer to applicable specification sections for related submittal requirements.

PART 2 - PRODUCTS

2.1 REFER TO APPLICABLE SPECIFICATION SECTIONS

PART 3 - EXECUTION

3.1 GENERAL

- A. Common Requirements
 - 1. Provide all necessary electrically related work as required to render all mechanical equipment (including plumbing, heating, ventilating and air conditioning equipment) fully operational and fully compliant with NEC. This includes, prior to ordering materials or commencing with rough-in, reviewing equipment submittal data and coordinating with installing contractors to ensure the correct size, rating and quantity of conductors are provided.
 - 2. Drawn locations of equipment and devices are shown only for schematic indication of wiring requirements. Coordinate with locations and rough-in requirements as required to

determine actual locations and termination requirements. Refer to all contract documents for additional electrical requirements and concerns, and for further representation of this work.

3. Provide raceway, wiring, connections, and terminations for power and interlocks for electrically operated equipment. Provide starters and disconnect switches for mechanical equipment unless specifically indicated otherwise herein or on the drawings.
4. Provide disconnect switch ahead of all equipment, including controls, unless the mechanical equipment comes with integral NEC-compliant disconnect(s). Provide NEMA 3R enclosures where installed outdoors and where installed indoors in areas subject to moisture. Ground metal frames of equipment by connecting frames to the grounded metal raceway or to a full size green ground conductor or both. Provide the necessary electrical connections between the specified equipment and the junction box near equipment with flexible metallic conduit (liquid-tight outdoors) and matched connectors (see Section 26 05 33). Where mechanical equipment lugs cannot accommodate conductor sizes shown on drawings, provide ILSCO ClearTap Insulated Multi-Tap Connectors.
5. Sizes, electrical ratings, etc. of equipment and wiring shown on drawings are based on the respective equipment design base manufacturers. If different manufacturer(s) or model(s) are actually supplied, provide necessary coordination in field (prior to ordering materials and prior to rough-in) and provide the necessary size of related electrical equipment, wiring, conduit, etc.
6. Prior to furnishing submittals and prior to rough-in, determine exact electrically related characteristics, loads, voltages, disconnect and starter requirements, locations, mounting heights, connection points, etc. of mechanical equipment.
7. Provide lugs, lug kits and related accessory work as required to accommodate the conductor sizes and quantities needed for each application. Coordinate with single-line diagram, field conditions, etc.

B. HACR Breakers

1. Coordinate in field with the respective trades and determine case by case, which equipment is factory listed for use with Heating and Air Conditioning Rated (HACR) breakers. In an effort to minimize requirements for stocking of fuses by the owner, utilize HACR breakers at the source panelboards as the NEC required overcurrent protection wherever possible (in lieu of fusing local disconnect switches).

C. Disconnect Switch and/or Starter Locations

1. Locations shown on drawings are indicated for schematic purposes only. Determine exact locations in field so that they are compliant with NEC Article 110.26.

D. Maintenance Receptacles for Equipment.

1. Provide duplex receptacle within 25 feet of all electrically operated equipment of any nature that requires periodic testing or maintenance. Provide Type WR duplex GFCI weatherproof receptacle for outdoor applications and for applications subject to high humidity or moisture. Provide Type WR duplex GFCI weatherproof receptacle at rooftop

within 25 feet of all electrically operated rooftop equipment of any nature that requires periodic testing or maintenance.

E. Heating, Ventilating and Air Conditioning (HVAC) Equipment

1. Refer to HVAC / Electrical Coordination Schedule (HECS) on drawings. Provide disconnects, starters, accessories, wiring, connections, services, etc. where defined as "EC" in the schedule. Information in this section supplements the information in the HECS.
2. Provide power wiring and connections for all equipment (including motor dampers and accessories where applicable) as required to render equipment fully operational.
3. Provide engraved plates at all local disconnects and starters with equipment identification and mark indicated.
4. Install local disconnects and starters at 48 inches to top of outlet box or enclosure as applicable above finished floor/slab/grade; provide flush mounted units in finished areas. Provide key operated manual starters where accessible to general staff and general public.
5. Heat Recovery Units
 - a. Provide separate power feeds or single power feed as directed in field by the HVAC installer (field verify prior to rough-in). Modify starter and disconnect requirements accordingly, if required. Provide additional dedicated 120V, 20A branch circuit for each unit from nearest panelboard (if not indicated clearly on the electrical drawings) for internal factory-installed lighting and receptacles. Provide conduit, wiring, and overcurrent protection for this work, and terminations to connections within the heat recovery units for this lighting and convenience power.
6. Split System Air Conditioning Systems
 - a. Provide (1) 3/4 inch empty conduit (with drag line) from each air handling segment to each condensing unit. Provide control conduit between pair to follow refrigerant piping routing wherever practical.
7. Ductless Split System Air Conditioning Units
 - a. Provide power, control and interlock wiring and connections, to indoor and outdoor equipment.
 - b. Provide local weatherproof fused disconnect at each outdoor condensing unit.
 - c. Provide power, control and interlock wiring in conduit from each outdoor condensing unit to respective indoor air conditioning unit. Determine specific wiring requirements in field from HVAC installer since these wiring specifics vary by manufacturer. Provide related wiring as required to render systems fully operational.
 - d. Provide 2-pole local flush snap switch disconnect at each indoor air conditioning unit (with pilot light).
 - e. Route control conduit/wiring between each air conditioning unit and respective condensing unit to follow refrigerant piping routing wherever practical.
 - f. Provide power home-run from each outdoor condensing unit, or from each indoor air conditioning unit, or from both unit for each application. Determine specific wiring requirements in field from HVAC installer since these wiring specifics vary by manufacturer. Provide related power home-runs as required to render systems fully operational.

F. Heating, Ventilating and Air Conditioning (HVAC) Control Wiring

1. General
 - a. Unless specifically indicated as empty conduit on drawings or herein, provide electrical control and interlock work as shown on drawings. Provide additional control work as specifically indicated herein.
 - b. Coordinate HVAC thermostat and sensor locations in field (case by case) with Architect, Owner's Representative and equipment installer to ensure that they are placed in locations that will not interfere with furniture, equipment, artwork, wall-hung specialties, room finishes, etc. Field-verify these wall locations case by case, prior to rough-in, since locations shown on drawings are schematic only.
2. Schematic Thermostat and Sensor Locations
 - a. Refer to HVAC drawings and documents.
3. Low Voltage Thermostats and Sensors
 - a. Provide 4 inch square by 2-1/8 inch deep wall outlet boxes at 46 inches above finished floor to center of outlet box (with single-gang rings) for each unit. Provide one 3/4 inch empty conduit from each location, turned out above accessible ceilings (in joist space or against overhead slab/deck). Identify conduit in ceiling cavity; provide sweep bends, bushings and drag line.

G. Plumbing Equipment

1. Refer to Plumbing / Electrical Coordination Schedule (PECS) on drawings. Provide disconnects, starters, accessories, wiring, etc. as defined as "EC" in the schedule.
2. Domestic Water Heaters (Electric)
 - a. Provide local disconnect switch, and power wiring and connections. Provide interlock wiring with circulating pumps, flow switches and aquastat controls as applicable. Refer to wiring diagrams on drawings for further definition where applicable.
3. Domestic Hot Water Circulating Pumps (Return Line)
 - a. Provide manual starter with pilot light, and wire pump to operate through the aquastat. Refer to wiring diagrams on drawings for further definition.
4. Electric Water Coolers (Surface)
 - a. Provide 120V duplex receptacle. Provide GFCI circuit breaker to feed the circuit that serves electric water coolers, even if not indicated on panelboard schedule. Install at height and location as directed by water cooler installer. Conceal outlet within water cooler enclosure if enclosure is designed for such an installation. Assemble and connect cord if needed. Coordinate all specifics with water cooler installing contractor prior to rough-in of related work.
5. Electronic Plumbing Fixture Valves
 - a. Provide electrical wiring and connections as required for full automatic operation of direct-wired electronic sensor operated lavatory, urinal and water closet valves.
 - b. Install and wire 120VAC/24VAC remote box mounted transformers. Install above nearby accessible acoustical tile ceiling and provide local single-pole switch above ceiling at the transformer to switch primary power. Provide secondary fusing if not

integral to the transformer (verify in field). Provide required 24VAC wiring (#14 AWG "MC" Cable with ground), concealed. Field coordinate work carefully prior to rough-in.

END OF SECTION 260584

SECTION 260590 - ELECTRICAL SPECIALTIES

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: Miscellaneous electrical specialty items.

1.3 ACTION SUBMITTALS

- A. Provide submittals for equipment, materials and systems specified in this section. Include product data, descriptive information, technical data, wiring diagrams, etc. Identify all information that is specific to this project.

PART 2 - PRODUCTS

2.1 ELECTRICAL SPECIALTIES

A. Hand Dryers

1. Provide Excel XLerator hand dryers Model XL-xx electric hand dryers.
2. Subject to compliance with specifications and project requirements, equivalent units by the following are acceptable: Dyson, World, Saniflow or Comac Blast Hand Dryer.
3. Provide factory Recess Kit, finished to match hand dryers. Fabricate wall box with 22 GA 18-8 type 304 stainless steel with #4 satin finish. Fabricate dryer mounting plate with 16 GA 18-8 type 304 stainless steel. Provide all welded construction. Provide 14-1/2" wide recess kit designed to fit in standard 3-1/2" deep stud wall (4" deep overall opening). Provide stainless steel cable connected to the dryer mounting plate to hold the dryer in position when servicing the unit. Note that when installed, the bottom of the hand dryer will be approximately 10 inches above the bottom of the rough wall opening. Provide the rough wall opening and the recess kit at heights above finished floor that result in the bottom of the hand dryer unit ending up at the height(s) specified in this subsection. Provide overall hand dryer assembly that meets ADA protrusion requirement of 4 inches or less out from finished wall surface.
4. Provide hand dryer covers that are one-piece, heavy-duty, rib-reinforced, die-cast zinc alloy, lightweight, unbreakable, rustproof, and installed with tamper-proof hardware.
5. Provide units with 10-15 second complete drying time.
6. Provide exposed surfaces that are brushed stainless steel.
7. Coat internal hand dryer parts according to Underwriters' Laboratories, Inc. requirements.
8. Internally ground entire mechanism.

9. Provide hand dryer motor with minimum air velocity of 16,000 LFM (linear feet per minute) at the air outlet and minimum 14,000 LFM at the hands (4 inches below air outlet).
10. Mount hand dryer heating element (1500 watt maximum) inside the blower housing so it is vandal proof. Protect unit with automatic resetting thermostat that opens whenever air flow is cut off and closes when flow of air is resumed. Provide unit that produces air temperature of up to 135°F at a 72°F ambient room temperature at the hands (4 inches below air outlet).
11. Provide 120 volt units, each with minimum #12 AWG circuit wiring fed from a dedicated 20A/1P branch breaker (verify with manufacturer's installation instructions prior to ordering breakers and prior to rough-in).
12. Provide infrared optical sensor located next to the air outlet that activates hand dryer control assembly. Provide unit that operates as long as hands are under the air outlet, with 35-second lockout feature if hands are not removed.
13. Coordinate all mounting heights with Architect prior to rough-in. Unless indicated otherwise on architectural documents or directed otherwise by Architect in field, install units at the following mounting heights (from finished floor to bottom of dryer). Where more than one unit is shown in a toilet room, coordinate with Architect regarding which units are to be installed at which heights.
 - a. Men's: First unit at 37 inches (for compliance with ADA for use by the handicapped), and additional units (if any) at 45 inches.
 - b. Ladies': First unit at 37 inches (for compliance with ADA for use by the handicapped), and additional units (if any) at 43 inches.
 - c. Teenagers': First unit at 37 inches (for compliance with ADA for use by the handicapped), and additional units (if any) at 41 inches.
 - d. Small Children: First unit at 37 inches (for compliance with ADA for use by the handicapped), and additional units (if any) at 35 inches.

PART 3 - EXECUTION

3.1 REFER TO APPLICABLE "PRODUCTS" SUB-SECTIONS ABOVE

END OF SECTION 260590

Submittal Form – 260590.00 – Electrical Specialties

Provide And Complete This Sheet And Submit As A Cover Sheet For Submittals Requested Within This Section.

Electrical Contractor: _____ Electrical Supplier: _____

Electrical Contractor Rep: _____ Electrical Supplier Rep: _____

Electric Contractor Ph. Number: _____ Electric Supplier Ph. Number: _____

Electric Contractor Rep Email: _____ Electric Supplier Rep Email: _____

Submitted Manufacturers (List Each Item, Type And Manufacturer):		

	Yes	No
Manufacturers Listed As Basis Of Design Or Listed Equivalent Manufacturers?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Manufacturers' Qualifications Meet Or Exceed Those Required Under Quality Assurance Section Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Manufacturers' Warranty Meets Or Exceeds The Warranty Period Specified Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Submitted Components Meet All Requirements Listed Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. RELATED SECTIONS

1. See Section 26 05 53.00 for special identification-related requirements.
2. See Section 26 05 33.00 for damp and wet location box and cover plate requirements.
3. See Section 26 27 26.00 for cover plates and related specialties.

1.2 SUMMARY

A. Section includes:

1. Manual lighting control devices
2. Occupancy sensors

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for all manual lighting control devices, occupancy sensors and time/light-based lighting controls.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include diagrams for power, signal, and control wiring for occupancy sensors and time/light-based lighting controls.

C. Special Additional Submittal Requirements for Occupancy Sensors

1. Sensor quantities, types and locations shown on drawings are shown only for schematic representation that a room or area is to have occupancy sensor control. Provide actual sensor quantities, types and locations as needed to provide fully operational coverage for each affected area, and based on submittal review comments by engineer, architect and/or owner.

2. Submit lighting plans clearly marked by manufacturer showing proper product, location, orientation and coverage (ultrasound or infrared or both as applicable) of each sensor along with quantity of sensors required to provide proper coverage for the respective room or space. Crop all coverage patterns at the extents of the room.
3. Select and locate sensors so that controlled lights automatically turn on immediately upon entering the room or space.
4. Select and locate sensors so that controlled lights will not be turned on by motion that occurs outside of the respective room or space (including applicable when doors are open).
5. Select and locate sensors so that full coverage for the respective room/area is provided.
6. Submit interconnection diagrams per major subsystem showing proper wiring.
7. Submit standard catalog literature that includes performance specifications indicating compliance to the specification.
8. Submit catalog sheets that clearly state load restrictions when used with electronic ballasts.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain lighting controls (including sensors, etc.) and lighting-control power distribution components from single manufacturer.

2.2 MANUAL LIGHTING CONTROL DEVICES

- A. See Section 262726 "Wiring Devices".

2.3 AUTOMATED LIGHTING CONTROL

- A. Photocells

1. Provide Tork #2107 (for 120/277 volt applications) and Tork #2104 (for 208/277 volt applications) photocells or equal by Intermatic, 2000W tungsten rated, 1800VA ballast rated, -40 to 140 degree F rated, fail-on, with contacts that remain closed from dusk to dawn (on at 1 to 5fc, off at 3 to 15fc). Provide delay of up to two minutes to prevent false switching due to vehicular lights or lightning. Provide mobile light level selector. Provide gasketed heavy duty die cast zinc housing and base. Determine exact mounting locations and adjustment requirements in field relative to structural and site conditions. Aim northward wherever not conflicting with artificial light sources.

2.4 OCCUPANCY SENSORS

- A. General

1. Related Work

- a. Provide labor, materials, tools, appliances, control hardware, sensor, wire, junction boxes and equipment necessary for and incidental to the delivery, installation and furnishing of completely operational occupancy sensor lighting controls, as described herein.
- b. Provide products supplied from a single manufacturer that has been continuously involved in manufacturing of occupancy sensors for a minimum of five (5) years.
- c. Provide occupancy sensors for entire project that are all made by the same manufacturer, regardless of where the materials are specified in Division 26 documents. Provide components that are all made by the same manufacturer in cases where occupancy sensor components are also connected to a building lighting control system, regardless of where the materials are specified in Division 26 documents.
- d. Provide components that are U.L. listed, offer a five (5) year warranty and meet state and local applicable code requirements.
- e. Provide products manufactured by an ISO 9002 certified manufacturing facility with a defect rate of less than one-third of one percent.

B. General Standards

1. Provide sensors capable of operating normally with electronic ballasts, PL lamp systems and rated motor loads.
2. Provide sensors with coverage that remains constant after sensitivity control has been set. Automatic reduction in coverage due to the cycling of air conditioner or heating fans is not permitted.
3. Provide sensors with readily accessible, user adjustable settings for time delay and sensitivity. Locate settings on the sensor (not the control unit) and recess to limit tampering.
4. Provide bypass manual override on each sensor to accommodate failures. Configure so that when bypass is utilized, lighting remains on constantly or control diverts to a wall switch until sensor is replaced. Recess this control to prevent tampering.
5. Provide sensors with an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation.
6. Where specified, provide sensor with internal additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options. Do not use sensors that utilize separate components or specially modified units to achieve this function.
7. Provide sensors with UL rated, 94V-0 plastic enclosures.

C. Basis-of-Design Product: WattStopper (model numbers as specified further below).

D. Acceptable Manufacturers: Subject to being equivalent and subject to compliance with requirements, provide product by one of the manufacturers listed below. If not listed, submit as substitution prior to final addendum for inclusion.

1. Cooper Greengate CA
2. Hubbell
3. LC&D
4. Leviton

5. Lutron
6. Sensor Switch
7. Phillips

E. Passive infrared sensors

1. Provide sensors that utilize Pulse Count Processing and Digital Signature Analysis to respond only to those signals caused by human motion and that provide high immunity to false triggering from RFI (hand-held radios) and EMI (electrical noise on the line). Provide sensors that also have multiple segmented Fresnel lens, in a multiple-tier configuration, with grooves-in to eliminate dust and residue build-up.

F. Dual technology sensors

1. Provide sensors that are either wall mounted, corner mounted or ceiling mounted in such a way as to minimize coverage in unwanted areas. Provide passive infrared and ultrasonic or microphonic technologies for occupancy detection.

G. Ultrasonic sensors

1. Provide sensors that utilize Advanced Signal Processing to adjust the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled space. Crystal control operating frequency at 25 kHz within $\pm 0.005\%$ tolerance, 32 kHz within $\pm 0.002\%$ tolerance, or 40 kHz $\pm 0.002\%$ tolerance to assure reliable performance and eliminate sensor cross-talk. Do not use sensors with multiple frequencies.

H. Ceiling Sensors

1. Provide Standard of Quality equal to WattStopper: WT-605, WT-600, WT-1105, WT-1100, WT-2205, WT-2200, WT-2250, WT-2255, WP-605, WP-1105, WP-2255, WP-2205, W-500A, W-1000A, W-2000A, W-2000H, UT-300, UT-305, UT-355, WPIR, HB-100, HB-150, DT-200, DT-205, DT-300, DT-305, DT-355, CX-100, CX-105, CI-200, CI-205, CI-300, CI-305, CI-355, CI-12 or CI-24 series.

I. Wall Switch Sensors

1. Provide Standard of Quality equal to WattStopper: PW-100, PW-100-24, PW-200, WI-200, WI-300, WS-200, WD-170, WD-180, WD-270, WD-280, WN-100-120, WN-100-277, UW-100, UW-100-24, UW-200, DW-100, DW-100-24 or DW-200 series.
2. Provide wall switch sensors capable of detection of occupancy at desktop level up to 300 square feet, and gross motion up to 1000 square feet.
3. Provide units that accommodate loads from 0 to 800 watts at 120 volts; 0 to 1200 watts at 277 volts and that have 180° coverage capability.
4. Provide wall switch products that utilize Zero Crossing Circuitry to increase relay life, protect from the effects of inrush current, and increase sensor's longevity.
5. Provide wall switch sensors that have no leakage current to load, in manual or in Auto/Off mode for safety purposes, and that have voltage drop protection.

6. Where specified, provide wall switch sensors with field selectable option to convert sensor operation from automatic-ON to manual-ON.
7. Where specified, provide vandal resistant wall switch sensors that utilize hard lens with minimum 1.0mm thickness. Do not provide products that utilize a soft lens.

J. Power and Auxiliary Packs

1. Provide Standard of Quality equal to WattStopper: B120E-P, B277E-P, BZ-100, LC-100, C120E-P, C277E-P, S120/277-P, AT-120 or AT-277 series.

K. Circuit Control Hardware

1. Control Units - For ease of mounting, installation and future service, provide control units that are able to be externally mounted through a 1/2" knock-out on a standard electrical enclosure and be integrated, self-contained units consisting internally of isolated load switching control relay and transformer to provide low-voltage power. Provide control units that provide power to a minimum of two (2) sensors.
2. Provide Relay Contacts with ratings of:
 - a. 20A - 120 VAC Ballast
3. Provide control wiring between sensors and controls units that is Class II , 18-24 AWG, stranded U.L. Classified, PVC insulated or TEFLON jacketed cable suitable for use in plenums.
4. Provide minimum #12 AWG wire gauge to and from the circuit control hardware relays.

PART 3 - EXECUTION

3.1 GENERAL

A. Installation

1. Provide grounded ("neutral") conductor in all lighting control device (switch, dimmer, occupancy sensor, etc.) wall outlet boxes, even if not immediately used.
2. Install equipment and devices only in electrical boxes that are clean, free from building materials, dirt, and debris, and after wiring work is completed. Install wall plates only after respective wall surfaces have received their final finish.
3. Prior to energizing circuits, test wiring for electrical continuity and for short-circuits. Subsequent to energizing, test wiring devices and demonstrate compliance with requirements, operating each operable device at least six times.

3.2 OCCUPANCY SENSORS

A. Installation

1. Locate and aim sensors in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer's recommendations. Provide ninety (90) to one hundred (100) percent

coverage in rooms to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the rooms. The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. Provide additional sensors if required to properly and completely cover the respective room.

2. Arrange a pre-installation meeting with manufacturer's factory authorized representative, at owner's facility, to verify placement of sensors and installation criteria.
3. Exercise proper judgment in executing the installation to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components.
4. Provide, at the owner's facility, the training necessary to familiarize the owner's personnel with the operation, use, adjustment, and problem solving diagnosis of the occupancy sensing controls.

B. Factory Commissioning

1. Upon completion of the installation, provide complete commissioning for controls by the manufacturer's factory authorized technician who will verify adjustments and sensor placement to ensure trouble-free occupancy-based lighting controls.
2. Provide the owner, the manufacturer and the electrical engineer with ten working days written notice of the scheduled commissioning date. Upon completion of related work, including fine tuning, provide factory authorized technician training to the owner's personnel in the adjustment and maintenance of the sensors.

END OF SECTION 260923

Submittal Form – 260923.00 – Lighting Control Devices

Provide And Complete This Sheet And Submit As A Cover Sheet For Submittals Requested Within This Section.

Electrical Contractor: _____ Electrical Supplier: _____

Electrical Contractor Rep: _____ Electrical Supplier Rep: _____

Electric Contractor Ph. Number: _____ Electric Supplier Ph. Number: _____

Electric Contractor Rep Email: _____ Electric Supplier Rep Email: _____

Submitted Lighting Control Manufacturers (List Type And Manufacturer):		

	Yes	No
Manufacturers Listed As Basis Of Design Or Listed Equivalent Manufacturers?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Manufacturers' Qualifications Meet Or Exceed Those Required Under Quality Assurance Section Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Manufacturers' Warranty Meets Or Exceeds The Warranty Period Specified Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Submitted Components Meet All Requirements Listed Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Product Data Is Included For Each Lighting Control Device?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Shop Drawings Are Included For Each Lighting Control Device That Is Part Of A System?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Special Additional Submittal Requirements For Occupancy Sensors Are All Included?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. See Section 26 05 33.00 for weatherproof cover plate requirements.
- C. See Section 26 05 53.00 for special identification-related requirements.
- D. See Section 26 09 23.00 for Occupancy Sensors.
- E. See E-series drawings for Occupancy Sensors.

1.2 SUMMARY

- A. Provide wiring devices, in types, characteristics, grades, colors, and electrical ratings for applications indicated which are UL listed and which comply with NEMA WD 1 and other applicable UL and NEMA standards. Verify color selections with Owner's representative.
- B. Section Includes:
 - 1. Receptacles
 - 2. Switches
 - 3. Wall-box dimmers
 - 4. Wall-switch and exterior occupancy sensors
 - 5. Device wall plates

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. SPD: Surge protection device.

- F. Tamper-resistant: This term and “safety type” shall be taken to mean the same thing for receptacles.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 2. Cord and Plug Sets: Match equipment requirements.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.6 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper)
 - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell)
 - 3. Hubbell Incorporated; Wiring Device-Bryant (Hubbell)
 - 4. Leviton Mfg. Company Inc. (Leviton)
 - 5. Pass & Seymour/Legrand (Pass & Seymour)
 - 6. Lutron Electronics, Inc. (Lutron)
 - 7. Hubbell Incorporated (Hubbell)
 - 8. Wiremold/Legrand (Wiremold)
 - 9. FSR Inc. (FSR)

- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. For receptacle circuits protected with 15A breakers, provide NEMA 5-15R equivalents for the devices shown below.
- D. Provide Weather-Resistant Receptacles with UL “WR” marking, compliant with NEC 406.8, for all applications in wet or damp locations.
- E. Where GFI protected receptacles are shown on drawings, provide a separate GFI receptacle for each one shown. Do not feed downstream receptacles from load-side (GFI-protected) terminals of upstream receptacles.

2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R (20A) or 5-15R (15A), UL 498, and FS W-C-596.
 - 1. Provide duplex and single specification grade receptacles, 2-pole, 3-wire grounding, self-grounding, green grounding screw, ground terminals and poles internally connected to mounting yoke, color coded base, 20-amperes, 125-volts, with metal plaster ears, back & side wiring, NEMA configuration 5-20R.
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 5351 (single), CR5362 (duplex)
 - b. Hubbell; HBL5351 (single), HBL5352 (duplex)
 - c. Bryant; 5351 (single), 5352A (duplex)
 - d. Leviton; 5351 (single), 5362 (duplex)
 - e. Pass & Seymour; 5351 (single), 5362 (duplex)

2.4 GFCI RECEPTACLES

- A. General Description:
 - 1. Straight blade, feed-through or non-feed-through type depending on application.
 - 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
 - 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; VGF20.
 - b. Hubbell; GF20#LA.
 - c. Bryant; GF20#LA.
 - d. Pass & Seymour; 2095.
 - e. Leviton; 6490

2.5 SPD RECEPTACLES

A. General Description: Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 1449, and FS W-C-596, with integral SPD in line to ground, line to neutral, and neutral to ground.

1. SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
2. Active SPD Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."

B. Duplex SPD Convenience Receptacles:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 5362BLS
 - b. Hubbell; HBL5362SA
 - c. Bryant; SP53LBLUA
 - d. Leviton; 5380
 - e. Pass & Seymour; 5362BLSP
2. Description: Straight blade, 125 V, 20 A; NEMA WD 6 Configuration 5-20R.

2.6 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Single Pole:
 - 1) Cooper; AH1221.
 - 2) Hubbell; HBL1221.
 - 3) Bryant; 1121
 - 4) Leviton; 1221-2.
 - 5) Pass & Seymour; CSB20AC1.
 - b. Two Pole:

- 1) Cooper; AH1222.
 - 2) Hubbell; HBL1222.
 - 3) Bryant; 4902
 - 4) Leviton; 1222-2.
 - 5) Pass & Seymour; CSB20AC2.
- c. Three Way:
- 1) Cooper; AH1223.
 - 2) Hubbell; HBL1223.
 - 3) Bryant; 4903
 - 4) Leviton; 1223-2.
 - 5) Pass & Seymour; CSB20AC3.
- d. Four Way:
- 1) Cooper; AH1224.
 - 2) Hubbell; HBL1224.
 - 3) Bryant; 4804
 - 4) Leviton; 1224-2.
 - 5) Pass & Seymour; CSB20AC4.

2.7 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
- B. Manufacturers' Names:
1. Cooper
 2. Hubbell
 3. Leviton
 4. Lutron
 5. Wattstopper
- C. Control: Continuously adjustable slider ; with single-pole or three-way switching equal to Lutron "Nova T". Comply with UL 1472.
- D. LED Dimmer Switches: Specification grade; modular; thin profile; compatible with dimming drivers; dimmer-driver combination capable of consistent full-range dimming.
- E. Do not break off side heat-sink sections when ganging.
- F. Provide dimmer and wall plate colors that match other wiring devices in the respective room.
- G. Multiple wallbox dimmers may be used sporadically throughout the project on common circuits; provide compatible dimmers accordingly.
- H. Provide dedicated neutrals for circuits serving loads controlled by dimmers.

2.8 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: satin finish stainless steel, equal to Leviton Type 430 series
 - 3. Material for Unfinished Spaces with surface-mounted outlet boxes: Galvanized steel
 - 4. Material for Indoor Damp Locations: satin finish stainless steel, equal to Leviton Type 430 series
 - 5. with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant. Refer to Section 26 05 33.00.
- C. **Provide receptacle wall plates with adhesive label identification of panel number and circuit number, voltage, phase, and amperes. Provide black lettering (1/4 inches high), and transparent background using P-touch style labels. Provide labels and lettering that are impervious to normal surrounding ambient heat and light. Install labels perfectly level/plumb. Utilize material that renders a virtually permanent adhesion, but that can be removed with a razor blade. Label inside of box with permanent marker indicating panel and circuit number.**

2.9 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: White unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. SPD Devices: Blue.
- B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Provide grounded (“neutral”) conductor in all lighting control device (switch, dimmer, occupancy sensor, etc.) wall outlet boxes, even if not immediately used.
2. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
3. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
4. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
5. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Wall Plate Installation:

1. A device plate shall be provided for each outlet to suit the device installed. All plates shall be installed with all four edges contacting the finished wall surface and aligned correctly vertically. The use of sectional device plates will not be permitted.

E. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

10. Install wiring devices only in electrical boxes that are clean; free from building materials, dirt, and debris. Install wiring devices after wiring work is completed. Install wall plates only after respective wall surfaces have received their final finish.
 11. Consider locations indicated on the drawings to be approximate (unless specifically dimensioned on drawings). Determine exact locations of each floor outlet, case by case, after consulting with Owner and Architect, and after reviewing architectural documents so outlets are properly located to accommodate the final furniture and equipment layouts. Study the general construction with relation to spaces and equipment surrounding each outlet.
 12. Do not use aluminum products in concrete.
 13. Fasten electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry. Support boxes independent of conduit.
- F. Receptacle Orientation: Install receptacles so that the ground pin is oriented in a consistent manner throughout the facility, so that the orientation is compliant with all prevailing codes and regulations, and so that the orientation is acceptable to the electrical inspector. Where no existing building standard or owner project requirement, install receptacles with ground pin up . Where receptacles are installed horizontally, install such that neutral connection faces up.
- G. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- H. Dimmers:
1. Install dimmers within terms of their listing.
 2. Verify that dimmers used for fan speed control are listed for that application.
 3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
- I. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- J. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.
- 3.2 GFCI RECEPTACLES
- A. Install feed-through-type GFCI receptacles where downstream receptacles are fed from the line side of the GFCI receptacle.
- 3.3 IDENTIFICATION
- A. Comply with Section 26 05 53.00 "Identification for Electrical Systems."

- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
- B. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
 - 1. Test Instruments: Use instruments that comply with UL 1436.
 - 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- C. Tests for Convenience Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- D. Wiring device will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 262726

Submittal Form – 262726.00 – Wiring Devices

Provide And Complete This Sheet And Submit As A Cover Sheet For Submittals Requested Within This Section.

Electrical Contractor: _____ Electrical Supplier: _____

Electrical Contractor Rep: _____ Electrical Supplier Rep: _____

Electric Contractor Ph. Number: _____ Electric Supplier Ph. Number: _____

Electric Contractor Rep Email: _____ Electric Supplier Rep Email: _____

Submitted Manufacturers (List Device Type And Manufacturer):		

	Yes	No
Manufacturers Listed As Basis Of Design Or Listed Equivalent Manufacturers?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Manufacturers' Qualifications Meet Or Exceed Those Required Under Quality Assurance Section Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Manufacturers' Warranty Meets Or Exceeds The Warranty Period Specified Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Submitted Components Meet All Requirements Listed Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Wiring Device Colors Have Been Coordinated With Architect?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Product Data Submittals Are Clear, Crisp And Distinctly Legible – Including Graphics?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Product Data Submittals Are Clearly Marked As To Exactly Which Devices Are Submitted For Review With The Understanding That All Unmarked Devices Will Be Ignored During Review?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Switches.
 - 2. Molded-case circuit breakers (MCCBs)
 - 3. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.

1.4 PERFORMANCE REQUIREMENTS

- A. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event." Refer to Specification Section 260548 for seismic performance requirements.

1.5 ACTION SUBMITTALS

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

- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Manufacturer's field service report.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. Include the following:
 - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.8 QUALITY ASSURANCE

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

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
 - 2. Altitude: Not exceeding 6600 feet (2010 m).

1.10 COORDINATION

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Provide lugs, lug kits and related accessory work as required to accommodate the conductor sizes and quantities needed for each application. Coordinate with single-line diagram, field conditions, etc.
- B. Fault Current Ratings
 - 1. Provide electrical distribution related equipment with appropriately braced terminals and properly rated breakers, fuses, etc. for the available fault currents.
 - 2. In existing buildings where fault current values are not indicated on drawings, coordinate with existing "upstream" distribution equipment, and provide equipment AIC ratings that meet or exceed same.

2.2 SWITCHES

- A. Acceptable Manufacturers: Subject to being equivalent and subject to compliance with requirements, provide product by one of the manufacturers listed below. If not listed, submit as substitution.
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Industry, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Characteristics:
 - 1. 50 through 60 Hz., with 200,000 RMS symmetrical interrupting current rating.
 - 2. 250VAC rated, for projects with service-entrance line to line voltage not exceeding 240V.
 - 3. 600VAC rated, for projects with service-entrance line to line voltage not exceeding 600V.
- C. Type HD, Heavy Duty, Single Throw: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate required fuses where applicable, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.
5. Service-Rated Switches: Labeled for use as service equipment.

2.3 MOLDED-CASE CIRCUIT BREAKERS

A. Acceptable Manufacturers: Subject to being equivalent and subject to compliance with requirements, provide product by one of the manufacturers listed below. If not listed, submit as substitution.

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
3. Siemens Industry, Inc.
4. Square D; a brand of Schneider Electric

B. Characteristics:

1. 50 through 60 Hz., with RMS symmetrical interrupting current rating as required to accommodate the available fault current for the respective application.
2. 250VAC rated, for projects with service-entrance line to line voltage not exceeding 240V.

C. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

D. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Provide adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

E. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

F. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

G. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.

3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Ground-Fault Protection: Comply with UL 1053; remote-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

2.4 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location. Refer to drawings for NEMA type. Provide the following enclosure types if not noted on drawings, or if not noted otherwise on drawings.
 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 2. Outdoor Locations: NEMA 250, Type 3R.
 3. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install individual wall-mounted units with tops at uniform height unless otherwise indicated, or unless units must be stacked vertically, or unless field conditions otherwise dictate.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.
- E. Install disconnect switches within sight of controller position unless otherwise indicated.

- F. Size units according to load being served or as noted on drawings, whichever requirement is larger. Provide units with horsepower ratings suitable to the loads where applicable. Install overloads and fuses as necessary to fulfill requirements of each application as applicable.
- G. Subsequent to completion of installation of equipment, energize circuits and demonstrate capability and compliance with requirements. Begin by demonstrating switch operation through six opening/closing cycles with circuit unloaded. Open each switch enclosure and inspect interiors, inspect mechanical and electrical connections, inspect fuse/overload installations, and verify accuracy of type and rating of fuses/overloads installed. Correct deficiencies then retest to demonstrate compliance. Remove and replace defective units with new units and retest.

3.3 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each unit, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges

END OF SECTION 262816

Submittal Form – 262816.00 – Enclosed Switches And Circuit Breakers

Provide And Complete This Sheet And Submit As A Cover Sheet For Submittals Requested Within This Section.

Electrical Contractor: _____ Electrical Supplier: _____

Electrical Contractor Rep: _____ Electrical Supplier Rep: _____

Electric Contractor Ph. Number: _____ Electric Supplier Ph. Number: _____

Electric Contractor Rep. Email: _____ Electric Supplier Rep Email: _____

Submitted Manufacturer: _____		
	Yes	No
Manufacturers Listed As Basis Of Design Or Listed Equivalent Manufacturers?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Manufacturers' Qualifications Meet Or Exceed Those Required Under Quality Assurance Section Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Manufacturers' Warranty Meets Or Exceeds The Warranty Period Specified In This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Submitted Components Meet All Requirements Listed In This Specification And On Drawings?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Product Data Submittal Information Specified In This Section Is All Included?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Shop Drawing Submittal Information Specified In This Section Is All Included?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Fault Current Bracing Meets Or Exceeds The Available Fault Current At Each Component?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Fault Current Ratings For All Overcurrent Protective Devices Meet Or Exceed The Available Fault Current At The Respective Overcurrent Protective Device?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Submittals Were Prepared After Coordinating Information Shown On Drawings In Power Eqt. Schedules, In Misc. Eqt. Schedules, In Feeder Schedule And On Single-Line Or Riser Diagram?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		

SECTION 264313 - SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

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 field-mounted SPDs for low-voltage (120 to 600V) power distribution and control equipment.
- B. Related Requirements:
 - 1. Section 26 27 26.00 "Wiring Devices" for surge protection receptacles

1.3 DEFINITIONS

- A. SPD: Surge protective device.
- B. SPD Type: Used to describe the intended application location of the SPD, either upstream or downstream of the main overcurrent protective device of the facility.
 - 1. Type 1 SPD – Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service equipment overcurrent device, as well as the load side, including watt-hour meter socket enclosures and intended to be installed without an external overcurrent protective device.
 - 2. Type 2 SPD – Permanently connected SPDs intended for installation on the load side of the service equipment overcurrent device; including SPDs located at the branch panel.
 - 3. Type 4 SPD – Recognized Component SPDs, including discrete components as well as component assemblies, which bear specific conditions of acceptability.
- C. Sinewave Tracking (Frequency Responsive Circuitry): Voltage independent, dedicated circuitry intended to mitigate the effects of switching or ringing surges that is specifically designed so that it can survive the surge environment. The performance of sinewave tracking circuitry is defined by the level to which it mitigates Ring Wave transients and can be demonstrated in the test results of IEEE C62.41.2-2002, Category A Ring Wave (2kV).
- D. VPR (Voltage Protection Rating): A rating selected from a list of preferred values as detailed in UL 1449 3rd edition and assigned to each mode of protection. The value of VPR is determined as the nearest highest value taken from a list of preferred values as detailed in UL 1449 3rd

edition to the measured limiting voltage determined during the transient-voltage surge suppression test using the combination wave generator at a setting of 6 kV, 3 kA.

- E. MCOV (Maximum Continuous Operating Voltage): The maximum designated root mean-square (rms) value of the power frequency voltage that may be continuously applied to the mode of protection of an SPD.
- F. Nominal Discharge Current (In): Peak value of the current, selected by the manufacturer from a list of values specified in UL 1449 3rd edition, through the SPD having a current wave shape of 8/20 where the SPD remains functional after 15 surges using the test procedure described in UL 1449 3rd edition.
- G. Modes of Protection: Electrical paths where the SPD offers defense against transient overvoltages. e.g. Each Line to Neutral (L-N), Line to Ground (L-G), Line to Line (L-L) and Neutral to Ground (N-G).
- H. Per Phase Ratings: 'Per-Phase' ratings for a three-phase Wye-connected SPD are determined by multiplying the kA per mode times the number of discrete modes of protection (directly connected suppression components), minus the value for the Neutral to Ground mode, divided by the number of phases.
 - PER-PHASE = (((KA PER MODE) X (# OF MODES))-(N-G MODE KA)) / (# OF PHASES)
- I. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
- J. OCPD: Overcurrent protective device.
- K. SCCR: Short-circuit current rating.

1.4 ACTION SUBMITTALS

- A. Refer to Section 260503, Submittals for Electrical Systems.
- B. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, maximum continuous operating voltage, weights and dimensions, wiring requirements, required OCPD and accessories.
 - 2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, nominal discharge current ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.
 - 3. Warranty duration and replacement policy.
 - 4. Manufacturer's installation instructions

5. Peak Surge Current Rating shall be independently tested by a 3rd party testing agency per IEEE C62.41-1991, Test Procedure: 8x20uS waveform, 6kV/3kA Pre-Measured Limiting Voltage and Post-Measured Limiting Voltage. This is the same test procedure section used for the NEMA LS-1 Standards. The report shall be part of the submittal package. Failure to provide a report shall be cause for rejection. Statements of compliance are not acceptable.

1.5 INFORMATIONAL SUBMITTALS

- A. Refer to Section 260503, Submittals for Electrical Systems.
- B. Field quality-control reports.
- C. Certificates of Conformity: For SPDs, certifying compliance with an UL listing/certification to the following standards:
 1. UL 1449 3rd edition
 2. UL 1283 (Filter Only)

1.6 CLOSEOUT SUBMITTALS

- A. Refer to Section 260503, Submittals for Electrical Systems.
- B. Operation and Maintenance Data: Closeout Submittal shall include operation, installation and specification data in closeout submittals.
- C. Certification: By Electrical Contractor (Installer) that installation complies with manufacturer's instructions.
- D. Warranty duration and replacement policy.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a UL testing agency, and marked for intended location and application.
- B. Manufacturer's Qualifications: Manufacturer must have at least 10 years experience in the engineering, design and manufacture of permanently connected SPDs. Manufacturer operates a Quality System Certified manufacturing facility as ISO 9001:2000 Compliant

1.8 COORDINATION

- A. Coordinate location of field installed SPDs to allow adequate clearances for maintenance and proximity to electrical bus in switchboard and panel board applications.

- B. SPDs shall be rated for the class and category of service necessary for the application.

1.9 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace SPDs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Minimum five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Provide all SPDs on this project by the same SPD manufacturer to ensure commonality and ease of owner maintenance.
- B. Basis-of-Design Product: Provide products manufactured by Surge Suppression Incorporated (model numbers as specified further below).
- C. Acceptable Manufacturers: Subject to being equivalent and subject to compliance with requirements, provide product by one of the manufacturers listed below. If not listed, submit as substitution.
 - 1. Advanced Protection Technologies Inc. (APT).
 - 2. Current Technology
 - 3. Liebert Corporation
 - 4. Surge Suppression Incorporated
 - 5. LEA International
 - 6. Leviton Manufacturing Co., Inc.
 - 7. General Electric
 - 8. Square D
 - 9. Eaton Corporation
 - 10. Siemens Industry, Inc.

2.2 GENERAL SPD REQUIREMENTS

- A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Comply with UL 1449.

2.3 DISTRIBUTION PANEL SUPPRESSORS (400 AMP AND LARGER)

- A. Basis of Design
 - 1. Surge Suppression Incorporated
 - a. SDLB3
 - 2. Liebert Corporation
 - a. SI-016
 - 3. Current Technology
 - a. CGP
- B. SPDs: Listed and labeled UL acceptable to authorities having jurisdiction as complying with UL 1449 Type 1 or Type 2. Comply with UL 1283.
- C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per mode shall not be less than 100 kA. This value shall be independently tested by a 3rd party testing agency.
- D. SPD shall have a Nominal Discharge Current Rating of 20 kA per mode for all modes.
- E. The Maximum Continuous Operating Voltage (MCOV) shall be at a minimum as follows:
 - 1. 120/208 Wye
 - a. L-N: 150V
 - b. L-L: 300V
 - c. L-G: 150V
 - d. N-G: 150V
- F. The SPD shall have Voltage Protection Ratings (VPRs) for modes shown above as follows:
 - 1. 120/208 Wye
 - a. L-N: 700V
 - b. L-L: 1,200V
 - c. L-G: 700V
 - d. N-G: 700V
- G. SPDs shall be or have the following features and accessories:
 - 1. Indicator light display for power to device and protection status.
 - 2. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.
 - 3. Surge counter.
 - 4. Permanently-mounted, parallel connected.
 - 5. Solid-state clamping components to limit the surge voltage and divert the surge current. SPD components that “crowbar” (e.g. spark gaps, gas tubes, SCR’s, etc.) are not allowed.

6. Capable of sustaining 115% of nominal RMS voltage continuously without degrading.
7. The SPD shall be tested and listed by an UL as a complete assembly to a symmetrical fault current rating greater than or equal to the available fault current at the location of installation at the connected panel, in accordance with NEC Article 285 and shall be marked with the short circuit current rating (SCCR). If the available fault current is unknown, then the SCCR of the SPD shall be 200 kAIC.
8. SPD system shall provide discrete protection for all modes for a three-phase Wye-connected SPD. Distinct and independent protection circuitry for each mode is required.

2.4 ENCLOSURES

- A. Indoor Enclosures: NEMA 1 or better.
- B. Outdoor Enclosures: NEMA 4 or better.
- C. Wire SPDs to a disconnecting switch or breaker, rated for minimum 30 amps, in the panel per manufacturer's installation instructions to ensure a means of disconnecting the SPD from the power source without de-energizing the panel or the connected loads. Circuit breaker rating to be sized such that breaker does not open prematurely removing surge suppression from the circuit. The use of direct bus bar connected SPDs is expressly prohibited and will be rejected.
- D. Existing Panelboards: Provide externally-mounted units. Provide flush mounted enclosures where protecting flush mounted distribution equipment; cut and patch walls as required. Do not splice leads where SPD units are provided with factory installed box connector fitting with factory leads. Install conductors with direct paths to and from SPD devices avoiding sharp bends, loops and excessive lengths. Install SPD components to the panelboard boxes as near as possible to the interior connection points; position or reposition the related branch breakers accordingly. Cut factory and field leads as required to minimize cable lengths.

2.5 CONDUCTORS AND CABLES

- A. Power Wiring Sizing: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install SPDs in strict accordance with manufacturer's instructions and the NEC.
- B. Comply with NECA 1.
- C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not

splice and extend SPD leads unless specifically permitted by manufacturer. In the case where the lead length exceeds 18 inches the installer must contact the SPD manufacturer for installation assistance. Do not bond neutral and ground.

- D. Install SPDs at service entrance on load side, with ground lead bonded to service entrance ground.
- E. Use crimped connectors and splices only. Wire nuts are unacceptable.
- F. Wiring:
 - 1. Power Wiring: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 - 2. Controls: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 - 3. Provide overcurrent protection (OCP) compliant with NFPA 70 for each SPD. Such OCP's that may be shown on drawings are shown for schematic purposes. Provide OCP's at ratings as recommended by SPD manufacturer for each application.

3.2 FIELD QUALITY CONTROL

- A. Electrical Contractor shall inspect, test, and adjust components, assemblies, and equipment installations, including connections to strictly comply with this specification.
 - 1. Compare equipment nameplate data for compliance with Drawings and Specifications.
 - 2. Verify that electrical wiring installation, anchorage, alignment, grounding, and clearances complies with manufacturer's written installation requirements and NEC requirements.
 - 3. After installing SPD devices but before electrical circuitry has been energized, test for compliance with requirements.
 - 4. Complete startup checks according to manufacturer's written instructions, if applicable.

An SPD will be considered defective if it does not pass these tests and inspections.

- B. Prepare test and inspection reports as follows:
 - 1. The SPD installation shall be certified by a licensed electrician that the installation is in accordance with the manufacturer's recommendations, NEC requirements and the requirements of the specification above. Any deficiencies noted shall be corrected by the Contractor. Provide written documentation of this inspection as part of the closeout documents/manual.

3.3 STARTUP SERVICE

- A. Complete startup checks according to manufacturer's written instructions.

- B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.
- C. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

- A. Train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 264313

Submittal Form - 264313.00 - Surge Protection For Low-Voltage Electrical Power Circuits

Provide And Complete This Sheet And Submit As A Cover Sheet For Submittals Requested Within This Section.

Electrical Contractor: _____ Electrical Supplier: _____

Electrical Contractor Rep: _____ Electrical Supplier Rep: _____

Electric Contractor Ph. Number: _____ Electric Supplier Ph. Number: _____

Electric Contractor Rep Email: _____ Electric Supplier Rep Email: _____

Provide Completed Table As Shown Below With Each Spd Listed. First Entry Completed As An Example Only.

Spd Protected Panel Name	Spd Type	Ocpd Size	Estimated Conductor Distance In Inches From Spd To Circuit Breaker.
L1aa	Type 2	30	--

Submitted Spd Manufacturer: _____	<input type="checkbox"/>	<input type="checkbox"/>
	Yes	No
Manufacturer Listed As Basis Of Design Or Listed Equivalent Manufacturer?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Manufacturer's Qualifications Meet Or Exceed Those Required Under Quality Assurance Section Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Manufacturer's Warranty Meets Or Exceeds The Warranty Period Specified Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Submitted Spd Devices Meet All Requirements Listed Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Conductor Distances To Spd Are Able To Be Kept As Short And Straight As Possible?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		

SECTION 265100 - LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Interior luminaires, lamps, and ballasts
2. Exit signs
3. Emergency lighting units
4. Emergency fluorescent power unit
5. Luminaire supports

B. Related Sections:

1. Section 26 09 23.00 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multi-pole lighting relays and contactors.
2. Section 26 27 26.00 "Wiring Devices" for manual wall-box dimmers LED sources.

1.3 DEFINITIONS

- A. BF: Ballast factor.
- B. CCT: Correlated color temperature.
- C. CRI: Color-rendering index.
- D. HID: High-intensity discharge.
- E. LER: Luminaire efficacy rating.
- F. Lumen: Measured output of lamp, luminaire, or both.
- G. Luminaire: Complete lighting unit consisting of lamps or sources, and some or all of the following components: optical control devices, sockets, mechanical components to support or attach the luminaire, and electrical and electronic components to start, operate, dim or control and maintain the operation of the lamps or LEDs.

1.4 ACTION SUBMITTALS

- A. Product Data: Arrange luminaire submittals in booklet form with separate sheets for each luminaire, assembled by luminaire "type" in alphabetical order. Submit details indicating compatibility with ceiling grid system. Provide lamp or source and ballast/low voltage transformer/LED driver schedules (by luminaire type). Provide technical submittal data in separately tabbed sections for lamp or source submittals and for ballast, low voltage transformer or LED driver submittals.
- B. Only fully complete submittals will be reviewed. Failure to provide lamp/source and ballast/low voltage transformer/LED driver submittals at time of luminaire submittal will result in immediate return of submittal package without review.
- C. Submit Lighting Control Device, System and Accessory submittal(s) at the same time and in conjunction with the Luminaire submittal to verify that all associated components are verified with each other. None of the submittals will be reviewed apart from the other; they will be returned, marked "Revise and Resubmit". Failure to provide all submittals pre-coordinated and concurrently will result in immediate return of submittals, without review, and marked "Revise and Resubmit" with no further comments. This applies for the following specification sections.
1. 26 09 23.00 Lighting Control Devices.
 2. 26 27 26.00 Wiring Devices.
- D. Include data sheets for the following:
1. Luminaire
 - a. Original manufacturer datasheets or first generation printed copies of manufacturer's electronic datasheet (i.e. printed copy of a PDF file).
 - b. Datasheets shall include dimensions, finishes and technical support data including energy efficiency data. Provide data sheets for applicable luminaire support and accessories.
 - c. Each datasheet to be labeled with the project name, luminaire "type" and exact catalog number. Affix to same location on each sheet.
 - d. Where datasheets depict multiple products, versions or options, the Contractor shall highlight (indicate with an arrow) all applicable model(s), version(s) and option(s) applying to the specific product the Contractor will be providing. The submitted items must be from "approved materials".
 2. Lamps
 - a. Original manufacturer datasheets or first generation printed copies of manufacturer's electronic datasheet (i.e. printed copy of a PDF file).
 - b. Datasheets shall include all technical data described in this section and data including, but not limited to, life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
 - c. Each datasheet to be labeled with the project name, luminaire "type" and exact catalog number. Affix to same location on each sheet.
 3. Ballasts

- a. Original manufacturer datasheets or first generation printed copies of manufacturer's electronic datasheet (i.e. printed copy of a PDF file).
 - b. Datasheets shall include all technical data described in this section and energy-efficiency data.
 - c. Each datasheet to be labeled with the project name, luminaire "type" and exact catalog number. Affix to same location on each sheet
4. LED Source and Driver System
- a. Original manufacturer datasheets or first generation printed copies of manufacturer's electronic datasheet (i.e. printed copy of a PDF file).
 - b. Datasheets shall include:
 - c. Voltage
 - d. Input watts
 - e. Energy efficiency data
 - f. Initial Lumen output
 - g. Source correlated color temperature (CCT)
 - h. Source color rendering index (CRI) value
 - i. Provide verification the system has been tested to IES LM-79-2008 standards
 - j. The system is RoHS compliant, lead free and mercury free
 - k. Name the LED manufacturer
 - l. Provide verification the LED's have been tested to IES LM-80-2008 standards and the rated life of the system in hours
 - m. Warranty for LED's and driver
 - n. Each datasheet to be labeled with the project name, luminaire "type" and exact catalog number. Affix to same location on each sheet
5. Exit signs, including battery.
6. Emergency lighting units, including battery and charger.
7. Emergency fluorescent lamp power unit, including battery and charger.
8. Scaled drawings and schematics of custom fabricated items. Drawings shall include dimensions, materials, weights, loads required clearances, method of field assembly, components, location and size of each field connection, and finish. These drawings shall be suitable for shop fabrication.
9. Scaled reflected ceiling plans and pertinent elevation drawings clearly depicting the intended location of custom fabricated equipment to be supplied. Equipment shall be presented to scale and dimensioned where necessary.
10. Supplemental information as necessary and/or required by the Designer to demonstrate full compliance with the contract documents.
11. Wiring Diagrams: For power, signal, and control wiring.]

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lighting equipment and luminaires to include in emergency, operation, and maintenance manuals.
1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes. List by luminaire "type".
 2. Provide a list of all ballast types used on Project; use ANSI and manufacturers' codes. List by "type".

3. Provide a list of all LED sources and driver types used on Project; use ANSI and manufacturers' codes. List by luminaire "type".

1.6 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. Lamps: 15 for every 100 of each type and rating installed. Furnish at least four of each type.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

1.8 COORDINATION

- A. Coordinate layout and installation of luminaires and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.9 WARRANTY

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 1. Warranty Period for Emergency Lighting Unit Batteries: five years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining years.
 2. Warranty Period for Emergency Fluorescent Ballast Batteries: five years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining years.
 3. Warranty Period for Self-Powered Exit Sign Batteries: five years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide products indicated on Drawings . Provide products of one of the manufacturers listed in this section for products that are not defined on the Luminaire Schedule. Provide specification grade luminaires that comply with minimum requirements as stated therein. If a particular "type" does not include basis of design manufacturer or model number, provide "pre-approved equivalent" manufacturer's and model numbers compliant with, and equivalent to: quality, performance, dimensions, and aesthetics as the respective basis of design for Designers review no less than five business days prior to bid due date.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES AND COMPONENTS

- A. Luminaires designated by letters are defined as indicated on the Luminaire Schedule.
- B. Provide luminaires, of sizes, types and ratings indicated; complete with, but not limited to, housings, energy-efficient lamps, lampholders, reflectors, energy efficient ballasts, starters and wiring. Ship luminaires factory-assembled, with components required for a complete operating installation.
- C. Recessed Luminaires:
1. Comply with NEMA LE 4 for ceiling compatibility for recessed luminaires.
 2. Provide recessed luminaires with necessary gypsum board, plaster frames, and surface trim.
 3. Provide recessed luminaires that are constructed without rolled edges and that are post-painted.
 4. Provide door frames on troffer style luminaires with spring latches on door frames.
 5. Provide static air function for luminaires unless otherwise noted.
 6. Provide luminaires that are non-IC constructed unless otherwise noted.
 7. Provide junction boxes and serviceable components (ballasts, thermal protection devices, fuses, etc.) for recessed luminaires that are accessible for service and replacement from below the ceiling, without removing ceiling components.
 8. Where plaster frames are inferred for luminaires (either by narrative, or by catalog number, or by application) interpret the actual function to mean for mounting within gypsum board, wet plaster or similar type inaccessible ceiling system. Field verify related requirements and provide required accessories, such as frames, accordingly.
 9. Provide UL approved (listed and labeled) thermal protection per latest edition of NFPA/NEC for recess mounted luminaires.
 10. Provide recessed fluorescent luminaires that are suitably constructed to operate with "P" rated ballasts as specified hereafter.

Review drawings and specifications of other trades to verify ceiling types, modules, and suspension systems appropriate to installation.

- D. Fluorescent Luminaires: Comply with UL 1598.
- E. Metal Parts: Free of burrs and sharp corners and edges.
- F. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Fabricate luminaires with concealed hinges and catches, with metal parts grounded as common unit, and so constructed as to dampen ballast generated noise
- H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp and ballast characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
 - c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
 - d. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
 - e. ANSI ballast type (M98, M57, etc.) for HID luminaires.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

- A. General Requirements for Electronic Ballasts:
 - 1. Provide same manufacturer and catalog number for ballasts of the same type. Refer to the drawings for input voltage requirements. If fusing requirements are indicated herein or on the Luminaire Schedule, fuse each ballast separately with a replaceable fuse external to the ballast.
 - 2. Provide ballasts that are compatible with power line carrier systems, and that do not adversely impact such systems.
 - 3. Provide luminaires shown on drawings with multi-level switching or similar special circuiting with multiple ballasts. Provide single ballasts wherever possible for other applications.
 - 4. Provide outdoor ballasts (or ballasts indoors, but in unconditioned areas) that are cold weather low starting temperature type (-20 degrees Fahrenheit).
 - 5. Comply with UL 935 and with ANSI C82.11.
 - 6. Designed for type and quantity of lamps served.

7. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
 8. Sound Rating: Class A.
 9. Total Harmonic Distortion Rating: Less than 10 percent.
 10. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 11. Operating Frequency: 42 kHz or higher.
 12. Lamp Current Crest Factor: 1.7 or less.
 13. BF: 0.88 or higher.
 14. Power Factor: 0.95 or higher.
- B. Luminaires controlled by occupancy sensors shall have programmed-start ballasts.
- C. Electronic Programmed-Start Ballasts for T8, T5 and T5HO Lamps: Comply with ANSI C82.11 and the following:
1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
 2. Automatic lamp starting after lamp replacement.
- D. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.
1. Ballast Manufacturer Certification: Indicated by label.
- E. Ballasts for Low-Temperature Environments:
1. Temperatures 0 Deg F and Higher: Electronic type rated for 0 deg F starting and operating temperature with indicated lamp types.
- F. Ballasts for Dimmer-Controlled Luminaires: Electronic type.
1. Dimming Range: 100 to 5 percent of rated lamp lumens.
 2. Ballast Input Watts: Can be reduced to 20 percent of normal.
 3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
 4. Control: Coordinate wiring from ballast to control device to ensure that the ballast, controller, and connecting wiring are compatible.
- G. Ballasts for Bi-Level Controlled Luminaires: Electronic type.
1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
 - a. High-Level Operation: 100 percent of rated lamp lumens.
 - b. Low-Level Operation: 30 percent of rated lamp lumens.
 2. Ballast shall provide equal current to each lamp in each operating mode.

3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

- A. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated: Solid State Rapid Start Electronic Fluorescent Lamp Ballasts - Compact Fluorescent Lamps

1. Lamp end-of-life detection and shutdown circuit.
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: Class A.
4. Total Harmonic Distortion Rating: Less than 20 percent.
5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. BF: 0.95 or higher unless otherwise indicated.
9. Power Factor: 0.95 or higher.
10. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

2.5 PROGRAMMED START DIMMING BALLASTS FOR FLUORESCENT LAMPS

1. Physical Characteristics
 - a. Ballast shall be physically interchangeable with standard electromagnetic or standard electronic ballasts, where applicable.
 - b. Ballast shall be available in a plastic/metal can or fully metal can construction to meet plenum requirements.
 - c. Ballast shall be provided with poke-in wire trap connectors or integral leads color coded per ANSI C82.11.
2. Performance Requirements
 - a. Ballast shall be Programmed Start.
 - b. Ballast shall be provided with integral protection circuitry to withstand connection of low voltage control leads to mains power supply. In this event, ballast shall default to maximum light output.
 - c. Ballast shall contain auto restart circuitry in order to restart lamps without resetting power.
 - d. Ballast shall operate from 50/60 Hz input source of 120V or 277V with sustained variations of +/- 10% (voltage and frequency) with no damage to the ballast. IntelliVolt models shall operate from 50/60 Hz input source of 120V through 277V with sustained variations of +/- 10% (voltage and frequency) with no damage to the ballast.
 - e. Ballast shall be high frequency electronic type and operate lamps at a frequency above 42 kHz to avoid interference with infrared devices and eliminate visible flicker.

- f. Ballast shall have a Power Factor greater than 0.98 at full light output and greater than 0.90 throughout the dimming range for primary lamp.
 - g. Ballast shall have a minimum ballast factor of 1.00 at maximum light output and 0.03 at minimum light output for primary lamp application.
 - h. Ballast shall provide for a Lamp Current Crest Factor of 1.7 or less throughout the dimming range in accordance with lamp manufacturer recommendations.
 - i. Ballast input current shall have Total Harmonic Distortion (THD) of less than 12% when operated at nominal line voltage with primary lamp.
 - j. Ballast shall have a Class A sound rating.
 - k. Ballast shall have a minimum starting temperature of 10C (50F) for primary lamp.
 - l. Ballast shall provide Lamp EOL Protection Circuit for T5, T5/HO, CFL lamps, and T8 lamps operating on 4-lamp ballast.
 - m. Ballast shall control lamp output from 100% - 3 % relative light output for T8 and CFL lamps and 100% - 1% relative light output for T5/HO lamps.
 - n. Ballast shall ignite the lamps at any light output setting without first going to another output setting.
 - o. Ballast shall tolerate sustained open circuit and short circuit output conditions without damage.
3. Regulatory Requirements
- a. Ballast shall not contain Polychlorinated Biphenyl (PCB).
 - b. Ballast shall be Underwriters Laboratories (UL) listed, Class P and Type 1 Outdoor; and Canadian Standards Association (CSA) certified where applicable.
 - c. Ballast shall comply with ANSI C62.41 Category A for Transient protection.
 - d. Ballast shall comply with ANSI C82.11 where applicable.
 - e. Ballast shall comply with the requirements of the Federal Communications Commissioning (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EM/RFI (conducted and radiated).
4. Other
- a. Ballast shall carry a five-year warranty from date of manufacture against defects in material and workmanship, including replacement, for operation at a maximum case temperature of 70C.
 - b. Ballast shall be controlled by a Class 1 or Class 2 low voltage controller.

2.6 EMERGENCY FLUORESCENT POWER UNIT

- A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body and compatible with ballast. Comply with UL 924.
1. Emergency Connection: Unless noted otherwise, operate two fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
 2. Test Push Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

- b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
3. Battery: Sealed, maintenance-free, nickel-cadmium type.
4. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
5. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
6. "EMCP" designation: Provide Bodine B50Cold-Pak or approved equivalent. Provide emergency ballast with temperature-control circuitry to fulfill both low-temperature and high-temperature operation. Provide emergency ballast with high-temperature, maintenance-free nickel cadmium battery, charger, and electronic circuitry contained in one nominal 13-3/8" x 2-3/8" x 1-1/2" red metal case. Provide solid-state charging indicator light to monitor the charger and battery, a single-pole test switch, and installation hardware. Provide emergency ballast capable of operating two 32 watt linear fluorescent lamps at 1200 lumens initial light output in the emergency mode for a minimum of 90 minutes. Provide unit that is suitable for use in damp locations and suitable for use in sealed & gasketed luminaires. Provide unit with storage and operating temperature range for the B50Cold-Pak of -20 degrees C to +55 degrees C. Provide emergency ballast UL listed for installation inside, on top of, or remote from the luminaire. Provide unit with full five year warranty from the date of purchase.
7. "EM11" designation: Provide Bodine B84CG or approved equivalent. Provide emergency ballast capable of operating one (26W-DTT), (26W-TRT), (32W-DTT), (32W-TRT), (42W-DTT), (42W-TRT), (or select lamps from Bodine cut sheet if different from those listed) normal or reduced mercury compact fluorescent lamp at (700), (1100), (850), (select lumen output based on table 2 in Bodine Catalog) lumens initial light output in the emergency mode for a minimum of 90 minutes. Provide emergency ballast circuit that delays AC ballast operation for five seconds upon restoration of normal power to prevent false-tripping of AC ballast end-of-life shutdown circuit. Provide unit with high-temperature, maintenance-free nickel cadmium battery, charger, and electronic circuitry contained in one nominal 21.5" x 1.18" x 1.18" galvanized steel case. Provide solid-state charging indicator light to monitor the charger and battery. Provide single-pole test switch. Provide installation hardware. Provide emergency ballast that is UL listed for installation inside, or on top of the luminaire. Provide full five year warranty from date of purchase.
8. "EM13" designation: Provide Bodine LP600 or approved equivalent. Provide emergency ballast capable of operating one 28 watt, T5 fluorescent lamp at 1245 lumens initial light output in the emergency mode for a minimum of 90 minutes. Provide emergency ballast circuit that delays AC ballast operation for five seconds upon restoration of normal power to prevent false-tripping of AC ballast end-of-life shutdown circuit. Provide unit with high-temperature, maintenance-free nickel cadmium battery, charger and electronic circuitry contained in one nominal 21.5" x 1.18" x 1.18" galvanized steel case. Provide solid-state charging indicator light to monitor the charger and battery. Provide single-pole test switch. Provide installation hardware. Provide emergency ballast that is UL listed for installation inside, or on top of the luminaire. Provide full five year warranty from date of purchase.
9. "EM14" designation: Provide Bodine B50U or approved equivalent. Provide emergency ballast with high-temperature, maintenance-free nickel cadmium battery, charger and electronic circuitry contained in one nominal 13-3/8" x 2-3/8" x 1-1/2" metal case.

Provide solid-state charging indicator light to monitor the charger and battery. Provide double-pole test switch. Provide installation hardware. Provide emergency ballast capable of operating two 32 watt, T-8 fluorescent lamps at 1350 lumens initial light output in the emergency mode for a minimum of 90 minutes. Provide unit with universal input that operates at any line voltage from 120 through 277 VAC at frequencies of 50 or 60 Hz. Provide emergency ballast UL listed for installation inside, on top of, or remote from the luminaire. Provide full five year warranty from date of purchase.

- B. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more fluorescent lamps, remote mounted from luminaire. Comply with UL 924.
1. Emergency Connection: Operate one fluorescent lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
 2. Battery: Sealed, maintenance-free, nickel-cadmium type.
 3. Charger: Fully automatic, solid-state, constant-current type.
 4. Housing: NEMA 250, Type 1 enclosure.
 5. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 6. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.7 [BALLASTS FOR HID LAMPS

- A. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features unless otherwise indicated:
1. Provide HID lamp ballasts manufactured by Advance, Valmont, Magnetek or Venture.
 2. Ballasts shall be pulse start and meet all federal or state energy legislation.
 3. Ballasts shall be electronic when available.
 4. Provide HID lamp ballasts, capable of operating lamp types and ratings indicated; constant wattage type, high power factor, fused (one per ungrounded power conductor) extra-quiet core and coil assembly encapsulated in non-melt resin; install capacitor outside ballast encapsulation for easy field replacement; and enclose assembly in drawn aluminum alloy housing(s) unless otherwise specified.
 5. Provide H.I.D. lamp ballasts, of ratings, types and makes as recommended by lamp manufacturer, which properly matches lamps to power line by providing appropriate voltages and impedances for which lamps are designed.
 6. Provide ballast designed such that it operates lamps within the lamp's power trapezoid requirements. Provide ballasts that are low noise.
 7. Where re-strike, or quartz re-strike, or emergency re-strike, or similar terms are specified on the Luminaire Schedule, provide system with time-delay relay for use with generators (for both hot re-strikes and cold starts) unless noted otherwise. Do not provide "auxiliary sockets".

8. Provide dedicated parity sized neutral conductor for each branch circuit phase conductor that serves H.I.D. luminaires.
 9. Provide ballast integral to luminaire unless directed otherwise. In no case is the ballast to be permanently affixed to the luminaire making replacement of the ballast impossible.
 10. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
 11. Minimum Starting Temperature: Minus 22 deg F for single-lamp ballasts.
 12. Rated Ambient Operating Temperature: 104 deg F.
 13. Open-circuit operation that will not reduce average life.
 14. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible luminaire noise.
- B. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:
1. Minimum Starting Temperature: Minus 20 deg F for single-lamp ballasts.
 2. Rated Ambient Operating Temperature: 130 deg F.
 3. Lamp end-of-life detection and shutdown circuit.
 4. Sound Rating: Class A.
 5. Total Harmonic Distortion Rating: Less than 20 percent.
 6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 7. Lamp Current Crest Factor: 1.5 or less.
 8. Power Factor: 0.90 or higher.
 9. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
 10. Protection: Class P thermal cutout.

2.8 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
 2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

- f. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.9 FLUORESCENT LAMPS

- A. Lamps shall be manufactured by G.E., Osram Sylvania or Philips.
- B. T8 rapid-start lamps, CRI 82 (minimum), and average rated life 20,000 hours unless otherwise indicated. Refer to Luminaire Schedule for wattage and color temperature.
- C. T5 rapid-start lamps, CRI 85 (minimum), and average rated life 20,000 hours unless otherwise indicated. Refer to Luminaire Schedule for wattage and color temperature.
- D. T5HO rapid-start, high-output lamps, CRI 85 (minimum), and average rated life 20,000 hours unless otherwise indicated. Refer to Luminaire Schedule for wattage and color temperature.
- E. Compact Fluorescent Lamps, Twin-Tube/Dual Twin-Tube and Triple-Tube, CRI 80 (minimum), color temperature as indicated in Luminaire Schedule, average rated life of 10,000 hours at three hours operation per start, and suitable for use with dimming ballasts unless otherwise indicated.

2.10 LIGHT EMITTING DIODE (LED) SYSTEMS

- A. Light Emitting Diode (LED) Systems
 - 1. LED Source
 - a. Provide factory installed LED modules that are specifically designed for, and matched and mated to, the respective luminaire in which they are used.
 - b. Provide LED modules that can easily be replaced in the field and are readily accessible for replacement.
 - c. Provide color temperature as indicated in Luminaire Schedule.
 - 2. LED Driver
 - a. Provide factory installed driver(s) for the LED source utilized that are specifically coordinated to the LED source and luminaire in which they are used.
 - b. Provide driver(s) having specific operating characteristics defined in the Luminaire Schedule.
 - c. Provide driver(s) that can easily be replaced in the field and are readily accessible for replacement.
 - d. Provide specification sheet for the specific driver as part of the Luminaire Submittal.

2.11 LUMINAIRE SUPPORT COMPONENTS

- A. Support fixtures in compliance with NEC.
- B. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- C. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- D. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single luminaire. Finish same as luminaire.
- E. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- F. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
- G. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- H. Hook Hangers: Integrated assembly matched to luminaire and line voltage and equipped with threaded attachment, cord, and locking-type plug.
- I. Provide additional supports as required in seismic areas.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Luminaires:
 - 1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
 - 2. Install lamps in each luminaire.
- B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.
- C. Remote Mounting of Ballasts: Distance between the ballast and luminaire shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.

- D. Lay-in Ceiling Luminaires Supports: Use grid as a support element.
1. Install ceiling support system rods or wires for each luminaire. Locate not more than 6 inches from luminaire corners.
 2. Support Clips: Fasten to luminaires and to ceiling grid members at or near each luminaire corner with clips that are UL listed for the application.
 3. Luminaires of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support luminaires independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
- E. Suspended Luminaire Support:
1. Pendants and Rods: Where longer than 48 inches brace to limit swinging.
 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers.
 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
 4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
- F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- G. Install surface and recessed ceiling luminaires on grid and tile ceilings to agree with module of ceiling either displacing a tile, or unit on center of tile, or centered on grid lines.
- H. Install flush mounted luminaires properly to eliminate light leakage between luminaire frame and finished surface.
- I. Do not locate splice or tap within an arm, stem, or chain. Provide wiring continuous from splice in outlet box of the building wiring system to lamp socket, or to ballasts terminals in fluorescent luminaires.
- J. Provide Type AC/MC Cable or wiring in minimum 1/2" diameter flexible metal conduit (with full parity sized green insulated equipment ground wire) for "drops" from building wiring system junction boxes to suspended ceiling mounted luminaires. Limit the length of these "drops" to 72". Install "drops" to luminaires in gypsum board, and similar inaccessible ceiling systems, from identified accessible junction boxes.
- K. Connect luminaires utilized for emergency egress lighting ahead of switching and other controls. The only exceptions to this are photocell-only controls for outdoor emergency egress luminaires.
- L. Provide luminaires and luminaire outlet boxes with hangers to properly support luminaire weight. Submit design of hangers, method of fastening, other than indicated or specified herein, for review by Owner's representative and review by ceiling installer. Anchor luminaires installed in, or on, suspended ceiling systems in strict compliance with NEC, including advance

coordination with the ceiling installer. Support surface mounted luminaires greater than 2 feet in length at a point in addition to the outlet box luminaire stud.

- M. Fasten electrical luminaires and brackets securely to structural supports. Install luminaires level and plumb.
- N. Where special mounting conditions are encountered, such as mounting to rounded columns or similar special circumstances, provide special factory fabricated mounting means (i.e., brackets designed to conform with curvature of rounded columns, or to conform with similar special surfaces).
- O. Provide stems and chains for luminaires as designated by the Owner's representative where deemed necessary by the owner's representative to achieve a functional and neat installation. Contact owner's representative to determine pendant, stem, and chain lengths if mounting height is not indicated.
- P. Provide plaster frames, or gypsum board frames, or similar kits for recessed luminaires installed in other than suspended grid type acoustical ceiling systems. Brace frames temporarily to prevent distortion during handling.
- Q. Wear clean white cotton gloves when handling the luminaires reflective and diffusing surfaces. Clean surfaces including dust, finger prints, paint, etc with a clean dry cheesecloth after interior work has been completed. Remove plastic shipping bags from luminaires only after work in the respective area is complete.
- R. Where applicable, verify that measured illuminance values comply with respective isolux (or equivalent) plot diagram values.
- S. Provide full assembly for luminaires that are shipped with any loose components, regardless of who furnishes the luminaires.

3.2 LIGHTING STANDARDS AND POST LIGHTS

- A. Utilize belt slings or rope (not chain or cable) to protect finishes of poles and standards when raising and setting finished poles and standards.
- B. Provide sufficient space encompassing hand access and cable entrance holes for installation of underground cabling where applicable.
- C. Fasten electrical poles, luminaires and brackets securely to structural supports.
- D. Provide concrete base for each luminaire standard pole. Provide base that is reinforced, and, unless indicated deeper on drawings, of the depth recommended by the manufacturer. Provide

galvanized steel washers, nuts and anchor bolts, in diameters, lengths and classes as directed by pole manufacturer.

- E. After ensuring that the poles are plumb, neatly fill the entire space between top of concrete bases and bottom of pole bases with grout. Provide poles with matching factory base covers ("skirts"). This applies even if not specifically indicated on Luminaire Schedule.
- F. Separately-fuse luminaires within the pole-base handholes.

3.3 IDENTIFICATION

- A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.5 STARTUP SERVICE

- A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.6 ADJUSTING

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

END OF SECTION 265100

Submittal Form - 265100.00 – Luminaires

Provide And Complete This Sheet And Submit As A Cover Sheet For Submittals Requested Within This Section.

Electrical Contractor: _____ Electrical Supplier: _____

Electrical Contractor Rep: _____ Electrical Supplier Rep: _____

Electric Contractor Ph. Number: _____ Electric Supplier Ph. Number: _____

Electric Contractor Rep Email: _____ Electric Supplier Rep Email: _____

Explanation Responses To Questions Below Must Indicate Specific Luminaire Type Comment Refers To.

	Yes	No
Luminaire Submittal Table Has Been Filled Out Completely And Is Attached With This Form?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Manufacturers Listed As Basis Of Design Or Listed Equivalent Manufacturer?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Manufacturer’s Qualifications Meet Or Exceed Those Required Under Quality Assurance Section Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Submitted Luminaires, Lamps (Sources), Ballasts (Drivers), And Associated Components Meet All Requirements Listed Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Manufacturer’s Warranty Meets Or Exceeds The Warranty Period Specified Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Are All Lighting Related Specification Sections, Including Those With Lighting Control Devices Or Systems, Being Submitted Concurrently With This Submittal?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		

<u>Type</u>	<u>Manufacturer</u>	<u>Series</u>	<u>As Specified (Yes or No)</u>	<u>Comments</u>

SECTION 281643 - PERIMETER SECURITY SAFETY

PART 1 - GENERAL

1.01 SCOPE

- A. This section details product and execution requirements for Security Management System (SMS) for the project.
- B. Work includes furnishing all labor, materials, tools and equipment, and documentation required for a complete turnkey working system as specified in this Section. SMS shall consist of but not be limited to Door Controllers, Card Readers, Sensors, Switches, Conduit, Boxes, Cable and Wired Devices. Programming and cardholder enrolling are also considered as part of installation as well as coordination with UKPD, NEXT LEVEL Security and Campus Security Integrator Dallmann Systems.
- C. Unless noted otherwise, "Contractor" shall refer to VMS / SMS Integrator & Installer.
 - 1. Communications routing from VMS / SMS Gateway to door controllers shall be via Owner LAN.

1.02 RELATED WORK

- A. Related Division 28 Sections include:
 - 1. 282300 - VIDEO SURVEILLANCE
- B. Related Sections in other divisions of Work:
 - 1. 087100 – DOOR HARDWARE
 - 2. 260000 - ELECTRIC
 - 3. 270000 - COMMUNICATIONS

1.03 REFERENCES AND STANDARDS

- A. Work under this Section is subject to requirements of Division 1 General Requirements.
- B. Other applicable standards are as follows:
 - 1. UL 294 - Access Control System Units.
 - 2. UL 1076 - Proprietary Burglar Alarm Units and Systems.
 - 3. FCC Rules and Regulations Part 15, Radio Frequency Devices
- C. All work and materials shall conform in every detail to rules and requirements of National Fire Protection Association, Kentucky Electrical Code, University of Kentucky Standards and University of Kentucky CNS Standards.

- D. All materials shall be listed by UL and shall bear UL label. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label entire system shall be so labeled.

1.04 DEFINITIONS AND ABBREVIATIONS

- A. SMS – Security Management System

1.05 WORK BY OWNER

- A. Owner shall:

1. Provide list of cardholders for initial SMS programming by Contractor.
2. Provide scheduling of each door, including:
 - a. Alarm activations and distribution.
 - b. Door lock and unlock.
 - c. Cardholder validation by day and time.
 - d. Delay time of door open alarm.
 - e. Duration of lock activation upon credential authorization.

1.06 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. System Design drawings with cable routing, device location and labeling, include AC power circuit information and location and if on Generator Life Safety circuit.
- C. Operation statements for all SMS doors.
- D. Communication Closet layouts.
- E. Certifications for NEXT Level and BICSI as required by UKCNS per Division 27000.
- F. Owner Operation Manuals for all installed equipment as well as documentation of all programming.

1.07 QUALITY ASSURANCE

- A. Security Management System Contractor shall:
 1. Have successfully completed two (2) Next Level Security Systems projects in equal magnitude of the system specified in following sections. Be fully certified by Next Level Systems for Sales and Installation of Next Level equipment. Proper proof of certification with Next Level will be submitted at time of Bid.

2. Comply with all certification requirements set out in Division 27000 as it related to the installation of DATA cabling. Specifically contractor will comply with the requirement of all DATA cabling being installed by BICSI certified installers and installation supervised by a registered in good standing RCDD in the full time employee of the project contractor.

1.08 GUARANTEE

- A. Warranty requirements for Security Management System (SMS) shall be five (5) years on all parts and labor commencing on Date of Substantial Completion. Those requirements apply to all components covered in this section

PART 2 - PRODUCTS

2.0 GENERAL

- A. Security Management System shall provide ability to:

1. Unlock electrified door locks upon authentication of submitted credential to local card readers.
2. Monitor door alarms and remotely unlock.
3. Lock doors on an automated schedule from central system.
4. Unlock doors as required by code via fire alarm relays.
5. Annunciate intrusion alarms from remote sensors.
6. Unlock individual doors manually via operator interface.
7. Lock doors from central Operations Center.

2.01 NETWORK SMS APPLIANCE: Gateway

- A. Manufacturer: Next Level Security Systems

1. Gateway: NLSS Gateway 4000 / Product Number: NLSS GW4000-UK.
NOTE: This is a special order product from NLSS.
 - a. Rack-mounted
2. Contractor will determine the correct number of Gateway units required for the project based on SMS and VMS needs to meet the UK Security Standards.

2.02 SYSTEM CONTROLLER

- A. Manufacturer: Mercury Systems AC-EP1501 or AC-EP1502. Controllers will include all power supplies, Life Safety FPO250 or Mercury Systems approved equal and Battery Units. All parts and pieces need for a complete UL listed working turnkey system.

2.03 MULTI-DOOR DOOR CONTROLLER

A. Manufacturer: Mercury Systems MR52.

1. Controller shall accommodate minimum two card readers and associated inputs/outputs.

2.04 PROXIMITY CARD READERS

A. Manufacturer: HID.

1. Wall-mount: Model RP40 (6125C) iClass Standard Reader.
2. Wall-mount: Model R90 (6150) iClass Long Range Reader (Used at ADA doors)
3. Mullion-mount Reader RP15 (6145C) multiCLASS

B. General

1. Reader(s) shall:
 - a. Be furnished in Wiegand output model and shall be sealed in a polycarbonate enclosure designed to withstand harsh environments.
 - b. Unless otherwise specified, reader covers shall be furnished in “Charcoal gray” color – Classic design.
 - c. Recognize 125 kHz and iClass 13.56 MHz signals
 - d. Contain an indicator to indicate valid and invalid card
 - e. Be designed for ambient operating environment.
 - f. Be powered remotely using centralized power supplies.
 - g. Read iClass Corporate 1000 sector information

2.05 DOOR CONTACTS

A. Specified by Division 8.

2.06 REQUEST-TO-EXIT MOTIONS SENSORS

A. Manufacturers: GE, Honeywell, or approved equivalent.

1. Provide door header mounted request to exit motion sensors as indicated on Drawings.

2. Minimum Specifications

- a. Detection technology Passive infrared.
- b. Detection pattern Narrow beam 35 degree cone.
- c. Output contact normally open contact is closed when sensing zone is entered or exited.

- d. Power requirements 12 – 24 VDC.
- e. Mounting: Door header.

2.07 POWER SUPPLIES

- A. As required to support Card Reader(s), Door Controller(s), Strike(s), Sensor(s) and other components for fully operational turnkey system.
- B. Electrified Door hardware power supplies specified by Division 8.

2.08 BADGE SYSTEM

- A. System must support the Campus Central One Card ID Badge.

2.09 CABLING

A. General

- 1. Cable shall be:

- a. Plenum Rated.

B. Reader Cable

- 1. Construction:

- a. 18 AWG stranded or as recommended by system manufacturer.
- b. Aluminum/Mylar shield with drain wire applied over assembled conductors.

C. Door Lock Power Cable

- 1. Provide and install as required for door hardware. Refer to Architectural Door Schedule and Door Hardware documents.

D. Door Contact/Signal Cable

- 1. Door Contact/Signal Cable used for monitoring purposes.
- 2. Construction:

- a. 22 AWG twisted, stranded or as recommended by system manufacturer.
- b. Aluminum/Mylar shield with drain wire applied over assembled conductors.

E. Request-to-Exit Motion Detector Signal Cable

- 1. Motion Detector Signal Cable used for monitoring purposes.

2. Construction:
 - a. 20 AWG stranded or as recommended by system manufacturer.
 - b. Aluminum/Mylar shield with drain wire applied over assembled conductors.

F. Door Controller Cable

1. Provide all LAN patch cables, jacks, and faceplates

PART 3 - EXECUTION

3.01 PRE-INSTALLATION COORDINATION

- A. Coordinate with Electrical Contractor (Division 26000) that:
 1. Pathways you provide and equipment back boxes are adequate for system installation.
 2. Adequate power has been provided and properly located for security system equipment.
 3. Code-complying fire alarm relays will be installed for cable termination.
 4. Coordinate scheduling of work.
- B. Coordinate with Door Frame supplier (Division 8000):
 1. Doors and door frames are properly prepared for electric locking hardware and door position switches are furnished by door type.
 2. Locations of all devices prior to installation.
 3. Electric door power supply locations and connections requirements.
- C. Coordinate with the Communications Contractor (Division 27000):
 1. Locations of all LAN-connected devices.
 2. Coordinate scheduling of work.
- D. At a minimum, coordinate the following with Owner:
 1. VLAN/or network partitioning for SMS system.
 2. Owner-provided IP addresses for SMS devices.
 3. Network infrastructure requirements at SMS head-end Next Level Gateway-4000UK.
 4. Initial database programming.
 5. Planned system downtime.
 6. Programming and training for new system.
- E. Coordinate with Construction Manager as required providing a fully functioning turnkey Security system.

- F. Coordinate with all trades on the operation and installation of ADA entrance doors with relation to Long Range Card Readers and interconnection with door actuator plates, motor units, and Fire Alarm. Contractor will supply any and all associated timer boards or additional parts required for complete operating doors system.

3.02 INSTALLATION

A. General

- 1. Verify acceptance of each type of specified request-to-exit hardware for each application with local life safety code officials.
- 2. Provide tamper proof fasteners for all equipment in public areas. Fastener finish shall match equipment finish.
- 3. Maintain minimum three feet of access in front of class 1 electrical equipment.

B. Delivery, Storage, and Handling

- 1. Deliver products to and receive products at site under provisions of General Requirements.
- 2. Materials shall be stored according to manufacturer's recommendations at minimum.

C. Equipment

- 1. Provide equipment as indicated on Drawings and specified herein. Additional specific installation requirements are as follows:
- 2. Door Controllers
 - a. Provide Door Controllers in Data Closets as shown on Drawings.
 - b. Separate 24 VDC and 120 VAC, wire, cable, and devices by 12" minimum space.
 - c. Enclose wire and cable in wire ways or bundle with wire exiting wire ways to terminal strips or panel mounted devices.
 - d. Space controllers according to manufacturer's requirements. Ensure adequate space is allowed for device heat dissipation.
 - e. Do not place controller or control devices on enclosure sides.
- 3. Card Readers
 - a. Provide card readers and card reader devices as shown on Drawings.
 - b. Wire card reader LEDs to indicate valid and invalid card reads, and door locked and unlocked conditions. All card reader LED indicators shall operate identically throughout Project. LED shall be red in normal, secured state, and shall be green on valid card read and while door is unlocked.

4. Electric Locking Mechanics
 - a. Interface with electric locking mechanics as required by the door hardware.
 - b. Provide lock control of electrified locking mechanics through output contacts activated by Door Controller.

5. Electrified Panic Devices
 - a. Interface with electrified panic devices as indicated on Drawings. Provide all low-voltage wire and connections between SMS power transfer device and electric locking mechanics.
 - b. Provide lock control of electrified panic devices through output contacts activated by Door Controller.

6. Door Position Switches
 - a. Install as shown on drawings.
 - b. Coordinate pathways.

7. Request-to-Exit Motion Sensors
 - a. Provide as shown on drawings.
 - b. Coordinate pathways.

8. Fire Alarm Interface
 - a. Connect (hard wire) door controller to building fire alarm system for fail-safe release upon any fire alarm.
 - b. Interface with a single low voltage / low current normally closed dry contact from fire alarm system provided by fire alarm Contractor (verify exact locations). Contact shall open on any fire alarm condition.
 - c. Provide all additional UL listed fail-safe relays and power supplies necessary to interface to this contact and unlock all fail-safe doors.

9. Cable Installation
 - a. Visually inspect all wire and cable for faulty insulation prior to installation.
 - b. Furnish and install all specified wire and cable as required for functioning SMS system.
 - c. Neatly lace, dress and support cabling.
 - d. Pull cables in accordance with cable manufacturer's recommendations University Of Kentucky CNS and ANSI/EEE C2 Standards.
 - 1) Do not exceed manufacturer's recommended pulling tensions.
 - 2) Do not install bruised, kinked, scored, deformed, or abraded cable.
 - 3) Do not splice cable between indicated termination, tap, or junction points.

- 4) Remove and discard cable where damaged during installation and replace it with new cable.
 - 5) Pull all cable by hand unless installation conditions require mechanical assistance.
- e. Run all wire and cable continuous from device location to final point of termination. No mid-run cable splices shall be allowed.
 - f. Cables shall not be attached to existing cabling, plumbing or steam piping, ductwork, ceiling supports, or electrical or communications conduit.
 - g. Cable shall never be laid directly on a ceiling grid or attached in any manner to ceiling grid wires.
 - h. Furnish and install all cable such that ample slack is supplied at device terminating end of cable to compensate for any final field modifications at install locations.
 - 1) Loosely coil slack in "Figure-eight" in a manner that prevents kinking.
 - 2) Loop radius shall be at least 4X minimum bend radius for cable.
 - 3) Slack length of cable shall be 4 feet (minimum).
 - i. Provide code-compliant fire proofing techniques for all penetrations of fire rated partitions and slabs, where penetrations are made by or used for installation of SMS System.
 - j. Coordinate routing of wire and cable requiring isolation from power, radio frequency (RF), electromagnetic interference (EMI), telephone, etc. with General Contractor.
 - k. At no time shall any cable be subjected to a bend less than manufacturer's specified minimum radius and UK CNS Standards.
 - l. Provide grommets and strain relief material where necessary to avoid abrasion of wire and excess tension on Wire and Cable.
 - m. Make connections with solder-less devices, mechanically and electrically secured in accordance with manufacturers' recommendations. Wire nuts shall not be an acceptable means of connecting wire and cable.

D. System Programming and Data Entry

1. Collect all data required to make the Security Management System operational. Deliver data to Owner on data entry forms, utilizing data from Contract Documents, Contractor's field surveys and all or pertinent information in Contractor's possession required for complete installation database. Identify and request from Owner any additional data needed to make SMS System fully operational and integrated. Completed forms shall be delivered to Owner for review and approval at least 30 days prior to Contractor's scheduled needed date. Contractor will coordinate with University of Kentucky Police Department and Campus Security System Integrator Dallmann Systems Incorporated (DSI) for database and Campus Cloud Services programming and Integration. A Fee of \$5,000.00 is required for any SMS / VMS Gateway connection to the Campus Cloud Services, paid to DSI. (Total per Building)

2. Provide all initial system programming and setup of SMS including, but not limited to following:
 - a. Graphical Maps and Icons
 - 1) Coordinate with Engineer to obtain AutoCAD Architectural backgrounds for implementation as graphical maps. Import all AutoCAD background information provided by Engineer and produce a complete set of graphical maps depicting all SMS points.
 - b. SMS Card Reader Information
 - 1) Coordinate all card reader values and text, including descriptors, alarm messages, Video camera call up, map call up and identification with Owner.
 - c. Input and output points for SMS. Coordinate all input and output priorities and text, including descriptors, alarm messages, Video Camera call up, and map call up and identification with Engineer.
 - d. Initial system users, including levels of access. This shall include designation of Owner's representative at "Super User" level immediately upon SMS initialization.
 - e. Initial Video camera call up and alarm information for interface with VMS system.
 - f. Program Elevator access per cardholder by cab and floor.
 - g. Initialize administrator interface to allow owner to update or terminate cardholder privileges and update card information.
- E. Furnish and install all SMS wire and cable including LAN cabling.
- F. Provide code-compliant fire proofing techniques for all penetrations of fire rated partitions and slabs, where penetrations are made by or used for installation of SMS.
- G. Cable Installation
 1. Utilize conduit and cable trays and or pathways to route SMS cables from each door or device to Door Controller. Follow University of Kentucky CNS standards for low voltage cabling.
 - a. No A/C current-carrying conductors are allowed in same pathway as signal or low-voltage power cables.
 2. Run all wire and cable continuous from device location to final point of termination. Mid-run cable splices shall not be allowed.

3. Wire and cable within Door Controllers, enclosures and or other security enclosures shall be neatly installed, completely terminated, pulled tight with slack removed and routed in such a way as to allow direct, unimpeded access to equipment within enclosure. All wire and cable shall be bundled and tied. Ties shall be similar to T&B TyRap cable ties.
4. Coordinate routing of wire and cable requiring isolation from power, radio frequency (RF), electromagnetic interference (EMI), telephone, etc.
5. Use of electrical tape for splices and connections shall not be acceptable.
6. Visually inspect all wire and cable for faulty insulation prior to installation.
7. Provide grommets and strain relief material where necessary to avoid abrasion of wire and excess tension on Wire and Cable.
8. Make connections with solder less devices, mechanically and electrically secured in accordance with manufacturers' recommendations. Wire nuts shall not be an acceptable means of connecting wire and cable.
9. All system cabling within vertical risers (as required) shall be bundled, wrapped and tied to structure at three meter intervals in order to isolate it from other wire and cable within riser. Provide all personnel and equipment necessary to install and support cable. All equipment shall be UL listed for application.
10. Furnish and install all specified wire and cable as required for functioning SMS system.
11. Neatly lace, dress and support cabling.
12. Pull cables in accordance with cable manufacturer's recommendations University Of Kentucky CNS and ANSI/EEE C2 Standards.
 - 1) Do not exceed manufacturer's recommended pulling tensions.
 - 2) Do not install bruised, kinked, scored, deformed, or abraded cable.
 - 3) Do not splice cable between indicated termination, tap, or junction points.
 - 4) Remove and discard cable where damaged during installation and replace it with new cable.
 - 5) Pull all cable by hand unless installation conditions require mechanical assistance.
13. Cables shall not be attached to existing cabling, plumbing or steam piping, ductwork, ceiling supports, or electrical or communications conduit.
14. Cable shall never be laid directly on a ceiling grid or attached in any manner to ceiling grid wires.

15. Furnish and install all cable such that ample slack is supplied at device terminating end of cable to compensate for any final field modifications at install locations.
 - 1) Loosely coil slack in "Figure-eight" in a manner that prevents kinking.
 - 2) Loop radius shall be at least 4X minimum bend radius for cable.
 - 3) Slack length of cable shall be 4 feet (minimum).
16. Provide code-compliant fire proofing techniques for all penetrations of fire rated partitions and slabs, where penetrations are made by or used for installation of SMS System.
17. Coordinate routing of wire and cable requiring isolation from power, radio frequency (RF), electromagnetic interference (EMI), telephone, etc. with General Contractor.
18. At no time shall any cable be subjected to a bend less than manufacturer's specified minimum radius and UK CNS Standards.
- H. 120 VAC power dedicated to security system shall be on provided, properly sized (following UKCNS specifications for 30 minutes run time) UPS units on generator backup circuits. Purchase these UPS units thru UKCNS.
- I. Connect to AC power with provided UL listed power supplies and transformers to distribute low voltage power to system components as required.
- J. Provide hinged cover UL listed terminal cabinets with tamper switches for all power supplies, transformers and power distribution terminal strips. Provide all conduit and wiring from AC power facilities to terminal cabinets.
- K. Provide protection against spikes, surges, noise, and or line problems for all system equipment and components.
- L. Provide protection on all exterior, control, power, signal cables and conductors against power surges. Each surge protector shall be UL Listed.
- M. In no instance shall any UL labeled door or frame be drilled, cut, penetrated, or modified in any way.
- N. Contractor shall be responsible for replacing any labeled door or frame that is modified without written approval from project Engineer.
- O. Label all controls as necessary to agree with their function.
- P. Label all Wire and Cable in common at both ends using a permanent method such as self-laminating cable marking tape.

1. Tags shall be attached to wire and cable nylon cable ties in an accessible location so that they can easily be read.
 - a. Tags shall be installed when wire and cables are installed.
 2. Labeling shall be consistent with existing cable labeling system and agree with Record Documentation.
- Q. Place wire identification numbers at each end of conductor involved by using sleeve type, heat shrinkable markers. Markers shall be installed so as to be readable from left to right or top to bottom.
- R. Mark all connectors with common designations for mating connectors. Connector designations shall be indicated on record drawings.
- S. Coil all spare conductors in device back box, panel wire way, or top of panel where wire way is not provided. Conductors shall be neatly bundled and tagged.

3.03 TRAINING

- A. Coordinate with Owner to establish a training outline and schedule. Submit a comprehensive training curriculum to Owner and Project Team once all preliminary coordination is complete. Owner will revise and comment on curriculum as required. Training will be coordinated with University of Kentucky Police Department in regards to operational system training.
- B. SMS
1. Provide a minimum of 2 hours of SMS operator training, and 2 hours of SMS administrative training, either on or off site on a complete and fully operational system parallel and equal to system being provided, to representatives of Owner.
 2. Operator training shall include, but not be limited to following:
 - a. All operating system procedures
 - b. System configuration
 - c. Alarm acknowledgment, alarm response logging, post-alarm system reset, and map graphics functionality.
 3. Administrative training shall include, but not be limited to following:
 - a. All operating system procedures and configuration variables
 - b. Database functions and setup
 - c. Card holder input and deletion procedures
 - d. Report generation
 - e. Applications programs (as applicable)
 - f. Map graphics generation and manipulation.

- C. Record, label, and catalog all training on DVD Videodiscs. Provide discs to Owner for future in-house training sessions and / or reviews. Furnish all temporary equipment necessary for taping all training sessions. Maintain accurate and up-to-date time sheets of all training sessions.
- D. Contractor shall be on call during Warranty period to answer any questions Owner might have. The Owner reserves the right to use any excess training hours, not used by time of system completion, for future training as requested by Owner until total number of training hours has been used.

3.04 SYSTEM START-UP

- A. Start-up includes all Contractor-Furnished, Contractor-Installed (CFCI) systems and equipment.
- B. Work shall be complete and ready to operate prior to final acceptance.
- C. All database programming for systems up to inaugural day of beneficial use of Security System shall be coordinated thru UKPD and Campus Security systems Integrator Dallmann Systems Inc.

3.05 SYSTEM ACCEPTANCE

- A. Final acceptance testing of Work will be conducted by DSI and observed by owner representatives and UKPD.
- B. Prior to any final acceptance testing, Contractor shall submit two sets of preliminary (draft) Record Drawings to owner and DSI. Preliminary Record Drawings are to be used by owner and DSI to conduct system final test.
- C. Conduct a complete test run of the entire Security System and provide a written report on results of that test. During course of this test, place integrated Security System in service, and calibrate and test all equipment. During SMS portion of test, an SMS manufacturer's representative shall be on site for not less than one full day to observe system operation and assist in optimizing SMS.
- D. Following completion of initial run testing and correction of any noted deficiencies, conduct a seven day burn-in test. Intent of burn-in test shall be to prove Security System by placing it in near real operating conditions. During this period Security System shall be fully functional and programmed such that all points, interfaces, controls, reports, messages, prompts, etc. can be exercised and validated. Record and correct any system anomaly, deficiency, or failure noted during this period. Scheduling of final acceptance test shall be based on a review of results of this burn-in test.
- E. Deliver a report describing results of functional tests, burn-in tests, diagnostics, calibrations, corrections, and repairs including written certification to Owner and Owner Representatives that installed complete Security System has been calibrated, tested, and is fully functional as specified herein.

- F. Prior to final acceptance test, coordinate with Construction Manager for security related construction clean-up and patch work requirements. Security equipment closets and similar areas should be free of accumulation of waste materials or rubbish caused by operations under Contract. At completion of Work, remove all waste materials, rubbish, Contractor's and subcontractors' tools, construction equipment, machinery and all surplus materials.
- G. Upon written notification from Contractor that Security System is completely installed and operational and burn-in testing is completed, DSI, Owner Representative and the UKPD will conduct a final acceptance test of entire system.
- H. System shall be complete and fully operational before requesting final acceptance and scheduling system Integration into the Campus Cloud Services. This Integration is coordinated thru University of Kentucky Police Department and the Campus Security Systems Integrator DSI.
- I. During course of final acceptance test Contractor shall be responsible for demonstrating that without exception, completed and integrated system complies with contract requirements. All physical and functional requirements of project shall be demonstrated and shown. This demonstration will begin by comparing "as built" conditions of Security System to requirements outlined in Specification, item by item. Following Specification compliance review, all Security System head-end equipment will be evaluated.
- J. During course of final acceptance test, an SMS manufacturer's representative shall be on site not less than one full day to assist in testing and be available to answer questions that Owner and Owner Representative may have during inspection.
- K. In order to sufficiently demonstrate Security System's functionality, contractor may be requested to perform certain daily operations inherent to Security System.
 - 1. These operations may include, but not be limited to following:
 - a. Manually locking and unlocking of doors within SMS
 - b. Verifying status of current alarm / control points within SMS
 - c. Verifying and responding to alarms
 - d. Generating standard and custom defined SMS reports.
 - e. Adding / deleting personnel from card holder database
 - f. Video Camera call-up on various monitors upon alarm
 - g. As all of the operations depend heavily on training outlined within Specification, Contractor shall have completed all of required training prior to initiation of final acceptance test.
- L. Functionality of all interfaces between systems will be tested including Fire Alarm and Smoke Evacuation System.

- M. Demonstration of the Room Lock Down feature will be required from each type of room installed. This test will not only include test of the security of area but also the confirmation of the Event notification of the UKPD Operations Center and the proper logging of the Event in system logs.
- N. Installation of field devices will be inspected by DSI, Owner and Owner Representative. This field inspection will weigh heavily on general neatness and quality of installations, complete functionality of each individual device, and mounting, back box and conduit requirements compliance.
- O. All equipment shall be on and fully operational during any and all testing procedures. Provide all personnel, equipment, and supplies necessary to perform all site testing. Provide a minimum of two employees familiar with system for final acceptance test. One employee shall be responsible for monitoring and verifying alarms while or will be required to demonstrate function of each device. Supply a means of communication between monitoring and testing groups for use during testing.
- P. Upon successful completion of final acceptance test (or subsequent punch list retest) DSI / Owner will issue a letter of final acceptance.
- Q. Owner retains right to suspend and / or terminate testing at any time when system fails to perform as specified. In event that it becomes necessary to suspend test, all of Owner's / Representative Fees and expenses related to suspended test will be deducted from Contractor's retainage. Furthermore, in event it becomes necessary to suspend test, Contractor shall work diligently to complete / repair all outstanding items to condition specified in Specification and as indicated on Drawings. Contractor shall supply Owner with a detailed completion schedule outlining phase by phase completion dates and a tentative date for a subsequent punch list retest. During final acceptance test, no adjustments, repairs or modifications to system will be conducted without permission of Owner.

END OF SECTION

SECTION 282300 - VIDEO SURVEILLANCE

PART 1 - GENERAL

1.01 SCOPE

- A. This section details product and execution requirements for VIDEO MANAGEMENT SYSTEM for the project.
- B. Work includes furnishing all labor, materials, tools and equipment, and documentation required for a complete turnkey working system as specified in this Section. VMS shall consist of but not be limited to, Cameras, Monitors, Gateway Appliances, Conduit, Boxes, Cable and Wired Devices. Programming and camera view setup is considered part of installation as well as coordination with UKPD, NEXT LEVEL Security and Campus Security Integrator Dallmann Systems.

Unless noted otherwise, "Contractor" shall refer to VMS / SMS Integrator & Installer.

- 1. Communications routing from VMS / SMS Gateway to door controllers shall be via Owner LAN.
- C. Coordinate with any and all trade contractors as required to provide a fully functioning system.
- D. Unless noted otherwise, "Contractor" shall refer to security system integrator & installer.
- E. Applicable provisions of Division 1 shall govern all work under this section.
- F. Video surveillance can be restricted or prohibited by law. This document details technical considerations only. It is assumed that registration, licensing, policies regarding disclosure and privacy (notification, processing of images, time and date stamping, recording of sound, etc.), and or legal obligations are responsibility of Owner.

1.02 RELATED WORK

- A. Related Division 28 Sections include:
 - 1. 281643 - PERIMETER SECURITY SAFETY
- B. Related Sections in other divisions of Work:
 - 1. 087100 - DOOR HARDWARE
 - 2. 260000 - ELECTRIC
 - 3. 270000 - COMMUNICATIONS

1.03 REFERENCES AND STANDARDS

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 1 General Requirements.
- B. All work and materials shall conform in every detail to rules and requirements of National Fire Protection Association, Kentucky Electrical Code, University of Kentucky Standards and University of Kentucky CNS Standards.
- C. All materials shall be listed by UL and shall bear UL label. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label entire system shall be so labeled.
- D. Other applicable standards are as follows:
 - 1. ANSI/IEEE C2 - National Electrical Safety Code
 - 2. NFPA 70-1999 - National Electrical Code
 - 3. IEEE/ANSI 142-1982 – Recommendations for Grounding of Industrial & Commercial Power Systems.
 - 4. NTSC/EIA RS-170A Video Standard
 - 5. IEEE 802.3 standards for CSMA/CD (Ethernet) based LANs
 - 6. Emissions: FCC 15, Class A; CE: EN55022 (Emissions)
 - 7. CE: EN50082-01 (Immunity)
 - 8. CE, UL 1950; CUL 1950 CE: EN60950 (Safety)
 - 9. State of Kentucky
 - 10. City of Lexington, KY

1.04 DEFINITIONS AND ABBREVIATIONS

- A. VMS – Video Management System
- B. SMS – Security Management System
- C. LAN – Local Area Network
- D. Gateway – Next Level Gateway 4000 Network Appliance: NLSS GW4000-UK

1.05 WORK BY OWNER

A. Owner shall provide:

1. Verify exact security device mounting locations.
2. Verify Acceptable per-camera field-of-view information.
3. Enterprise-wide Data Network / LAN to be utilized by VMS system.
4. Cross-connections from VMS components to building LAN, contractor provides all interconnection cables (Patch Cables) as needed but may not connect to LAN without CNS oversight and approval.
5. All active LAN components (switches, routers) as required for Security system function.
6. IP-address allotment and management for VMS devices as needed.

1.06 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. System Design drawings with cable routing, device location and labeling, include AC power circuit information and location and if on Generator Life Safety circuit.
- C. Communication and Security Closet layouts.
- D. Camera View Modeling.

1.07 QUALITY ASSURANCE

A. Video Management System Contractor shall:

1. Have successfully completed two (2) Next Level Security Systems projects in equal magnitude of the system specified in following sections. Be fully certified by Next Level Systems for Sales and Installation of Next Level equipment. Proper proof of certification with Next Level will be submitted at time of Bid.

1.08 GUARANTEE

- A. Warranty requirements for Video Management System (VMS) shall be five (5) years on all parts and labor commencing on Date of Substantial Completion. Those requirements apply to all components covered in this section

PART 2 - PRODUCTS

2.01 GENERAL

- A. VMS system shall deliver high quality; color video over an IP, UTP structured cable system using H.264 compression and shall provide for monitoring and recording of all cameras in system as indicated herein and on project Drawings. The VMS allows event-based monitoring of campus and situational awareness through IP cameras centrally managed from the University of Kentucky Police Department Operations Center. The VMS utilizes analytics to identify potential situations on campus and preserving evidence for authorities to review. The NLSS VMS has the capability to be securely monitored via mobile devices or off-campus locations, video sharing with outside public safety first responders.
- B. Video shall be configurable from a workstation on the University LAN using standard Browser software.

2.02 IP VIDEO CAMERA (FIXED)

- A. Interior Camera Shall be: Sony SNC-VM601B, Samsung SNV-7082 or approved equivalent.
- B. Exterior Cameras Shall be: Axis P3346-VE or approved equivalent.
- C. Camera shall:
 - 1. Be ceiling / wall mountable dome-type.
 - 2. Be IP-native.
 - 3. Utilize Power-over-Ethernet (PoE) for device power.
 - 4. Be designed to provide video streams at the minimum HDTV 720p (1280x1024) resolution at 30 frames per second using H. 264.
 - 5. Be equipped with Day/Night functionality, Wide Dynamic Range (WDR), color video to ½ lux, black and white below ½ lux and feature remote back focus capabilities.
 - 6. Be provided complete with standard interior (3-9 mm nominal) auto-iris lens.
 - a. Per-camera lens selection dependent upon Owner-required field-of-view.
 - 7. Have a smoked bubble.
 - 8. Have housing and mount color to match surrounding architectural colors.

2.03 NETWORK VIDEO APPLIANCE: Gateway

A. Manufacturer: Next Level Security Systems

1. Gateway: NLSS Gateway 4000 / Product Number: NLSS GW4000-UK.
 - a. Rack-mounted
2. Video Storage: 8TB On board Storage (UK NLSS Gateway 4000)
 - a. Provide proper number of Gateways to accommodate the number of cameras needed for the project. Gateways must provide 30 Days of local storage for all cameras recording per UK Security Standards. Exact number of Gateways used must be approved by Next Level Security Systems and UKPD.
 - b. Storage capacity calculations shall be based on 24/7 recording at a minimum 15 Frames Per Second.
 - c. Future capacity of Fifty Percent (50%) should be included for future camera installations. This should be calculated in the number of Gateways provided for the project.

B. QUALITY ASSURANCE

1. Qualifications
The system will be manufactured using the ISO 9001 certified procedures.

C. DELIVERY, STORAGE AND HANDLING

1. Delivery, storage, and handling of the system will be in accordance with the manufacturer's recommendations.
2. The manufacturer's ordering instructions and lead-time requirements will be followed to avoid delivery and installation delays.

D. WARRANTY

1. Manufacturer will provide a limited warranty for the outdoor camera pole to be free from defects in material or workmanship for a minimum period of three years.

2.04 WIRE AND CABLE

A. General

1. Provide and install all device DATA cables as per UKCNS and Division 27000 requirements. DATA cabling for Security cameras shall be terminated in each DATA Closet, in approved labeled patch panels (As per Division 27000 requirements). Camera

cabling should be terminated in jacks at the camera device. Contractor to provide all patch cables. All exterior camera cables shall be provided with Surge protection units on each cable. Proper cable types must be as per UKCNS standards and Division 27000 requirements.

2. Provide all interconnecting system cabling at Security Closets and Communication Closets as well at security device end points. All UKCNS standards must be followed.
3. Bond metallic system components in all Communications Closets and Security Closets to existing in-room ground bar.
4. Confirm and provide any necessary interface cabling with existing Access Control system.

PART 3 - EXECUTION

3.01 GENERAL

- A. Work performed for installation of VMS system shall be performed by Security System Integrator – “Contractor”.
- B. Provide equipment as indicated on Drawings and specified herein.
- C. Provide all labor and materials necessary to construct systems as described herein to include furnishing and installing all system equipment, interconnecting cabling, programming and start-up, software (including software upgrades and reprogramming as necessary), termination components, mounting hardware, incidentals, accessories, testing, labeling, documentation and training as detailed in following sections.
 1. Neatly lace, dress and support cabling.
 2. Coordinate any downtime with Owner.
- D. Prior to installation:
 1. Conduit and equipment back boxes are as required. Contractor is responsible for coordination with all trades to insure that conduit and back boxes are correctly placed for VMS use. Contractor is responsible for coordinating installation of conduit and boxes to make sure they are installed on schedule with other trades and are coordinated as to not interfere with other systems or pathways.
 2. 120V AC Power is as required and is properly located.
 3. LAN structured cabling is as required and properly located and installation has been coordinated with other trades.
 4. Coordinate all devices and locations prior to equipment installation with owner.

5. Coordinate Owner-desired camera views, providing camera modeling prior to installation.
6. Coordinate Camera housing and mount finishes with Architect and Owner.
- E. Install and wire equipment in accordance with University of Kentucky CNS Standards, manufacturer's recommendations, and accepted engineering and installation practices.
- F. Mount system components as recommended by manufacturer. All equipment mounting in Communication Closets must be approved by UK CNS prior to installation.
 1. Arrange equipment to facilitate permanent access for use and maintenance.

3.02 CABLE INSTALLATION

- A. Neatly lace, dress and support cabling.
- B. Pull cables in accordance with cable manufacturer's recommendations and ANSI/EEE C2 Standards as well as University of Kentucky CNS Standards and all Division 27000 requirements.
 1. Do not exceed manufacturer's recommended pulling tensions.
 2. Do not install bruised, kinked, scored, deformed, or abraded cable.
 3. Do not splice cable between indicated termination, tap, or junction points.
 4. Remove and discard cable where damaged during installation and replace it with new cable.
 5. Pull all cable by hand unless installation conditions require mechanical assistance.
- C. Run all wire and cable continuous from device location to final point of termination. No mid-run cable splices shall be allowed.
- D. Furnish and install all cable such that ample slack is supplied at device terminating end of cable to compensate for any final field modifications in camera location.
 1. Loosely coil slack in "Figure-eight" in a manner that prevents kinking.
 2. Loop radius shall be at least 4X minimum bend radius for cable.
 3. Slack length of cable shall be 4 feet (minimum).
- E. Provide code compliant fire proofing techniques for all penetrations of fire rated partitions and slabs, where penetrations are made by or used for installation of CCTV System.

- F. Coordinate routing of wire and cable requiring isolation from power, radio frequency (RF), electromagnetic interference (EMI), telephone, etc. with Engineer.
- G. At no time shall any cable be subjected to a bend less than manufacturer's specified minimum radius. Also refer to UK CNS Standards.
- H. Provide grommets and strain relief material where necessary to avoid abrasion of wire and excess tension on Wire and Cable.
- I. Make connections with solder-less devices, mechanically and electrically secured in accordance with manufacturers' recommendations. Wire nuts shall not be an acceptable means of connecting wire and cable.

3.03 IP VIDEO CAMERAS

- A. Mount Video Cameras per project drawings.
- B. Field-verify exact locations and field-of-views with Owner prior to installation.
- C. Provide video camera lenses to accommodate Owner-coordinated field-of-view per camera.
 - 1. Field verify and confirm views with Owner prior to procurement and final installation and adjust camera positions and lens sizes as required upon installation.
- D. Configure resolution, frame rate, password, etc. to match existing system installation, coordinate with UKPD.
- E. Coordinate with Owner prior to installation to confirm required parameters.
- F. Wire interface(s) to external alarms.

3.04 NETWORK CONNECTION

- A. Cross-connections to building LAN by Owner, NO EQUIPMENT MAY BE CONNECTED TO UK NETWORKS BY ANY SUB CONTRACTOR, ONLY BY UK CNS personnel.

3.05 LABELING AND IDENTIFICATION

- A. Labeling protocols to match all UK Security System installations.
 - 1. Cabling, Hardware and Equipment shall be clearly labeled using a Code identifying each piece as unique throughout Video Camera System. This code will aid in identifying hardware for servicing and maintenance.
 - 2. Labels and Tags shall be machine-generated using English character set in black ink on white background labels and Tags and shall be wrapped around type for cabling.

- a. Self laminating permanent labels are required on cables; permanent non-marring labels are required on all other hardware/cabinets.
 - b. No hand-written Labels or Tags shall be allowed.
 - c. Dymo or Kroy type adhesive backed lettering is not acceptable.
- B. Identify and tag all cables to denote function.
1. Tag shall indicate:
 - a. System of which cable is a part,
 - b. Indication of cable destination (e.g. room or component), and
 - c. Unique alpha-numeric identifier that distinguishes cable from all others in system.
- C. All labels shall be machine generated. Handwritten labeling is not acceptable.
- D. Label all front panel controls used in normal operation of system using plastic laminate engraved labels, or approved equal.
1. Firmly affix to panel or device.
- E. Labeling Formats
1. To be defined by Owner prior to construction following practice for all campus Security System installations.

3.06 SYSTEM TESTING AND ACCEPTANCE

- A. System shall be complete and fully operational before requesting final acceptance and scheduling system Integration into the Campus Cloud Services. This Integration is coordinated thru University of Kentucky Police Department and the Campus Security Systems Integrator Dallmann Systems Incorporated (DSI). A fee of \$5,000.00 will be paid to DSI for the final acceptance and connection to the Campus Cloud Services any SMS / VMS Gateway, (Total per Building).
- B. Installation of all field devices will be inspected by Owner or Owner's representative. Inspection will consider overall neatness and quality of installation, functionality of each individual device, mounting, wiring and labeling.
- C. Conduct a seven day burn-in test. Intent of burn-in test shall be to prove System by placing it in near real operating conditions prior to connection to Campus Cloud Services.

1. During this period System shall be fully functional and programmed so that all points, controls, messages, prompts, etc. can be exercised and validated.
- D. Provide written notification to Owner that system is completely installed, integrated, burn-in testing completed and is fully functional as specified herein.
1. Submit schedule for acceptance testing. Representatives of Owner, UKPD and/or representative may witness test procedures.
 2. Notify Owner UKPD and the representative in writing a minimum of two weeks in advance to allow for such participation.
 3. Describe test procedures prior to testing and submit sample test form to Owner / Representative.
- E. Prior to final acceptance test, equipment rooms and similar areas should be free of accumulation of waste materials or rubbish caused by operations under Contract.
- F. Equipment shall be on and fully operational during any and all testing procedures.
1. Provide all personnel, equipment, and supplies necessary to perform site testing.
 2. Supply a form of communication with remote parties in the team for use during test.
 3. A manufacturer's representative shall be present on site to answer any questions that may be beyond technical capability of Contractor's employees, if Contractor so elects or by specific request of Representative Owner, at no charge to Representative or Owner.
- G. During course of final acceptance test, Contractor shall be responsible for demonstrating that, without exception, provided VMS complies with contract requirements.
- H. Testing shall include but not be limited to:
1. Continuity and conductor/connector integrity on all cables.
 2. Demonstrate functionality of all cameras including:
 - a. Owner-acceptable field of view.
 - b. Response to alarms.
 - c. Response to Access Control System inputs.
 3. Confirm remote viewing, configuration and camera control via Browser and in the UKPD Operations Center. Confirm all Analytic uses on Cameras programed for Analytic use.
 - a. Confirm system rights settings for authorized users.

4. Demonstrate storage and retrieval of recorded video by date/time.
- I. Owner retains the right to suspend and/or terminate testing at any time when system fails to perform as specified.
 1. In event it becomes necessary to suspend test, Contractor shall work diligently to complete / repair all outstanding items to condition specified in Specification and as indicated on Security Drawings.
 2. All of Owner's / Representative Fees and expenses related to suspended test will be deducted from Contractor's retainage.
 3. Contractor shall supply Owner with a detailed completion schedule outlining phase by phase completion dates and a tentative date for a subsequent punch list retest.
 4. During final acceptance test, no adjustments, repairs or modifications to system will be conducted without permission of Owner.
 - J. Upon successful completion of final acceptance test (or subsequent punch list retest) Owner or Representative will issue a letter of final acceptance.
 - K. Records of Test Results shall be included in System Documentation and submitted as detailed below.

3.07 OWNER TRAINING

- A. Training course for system covered in this section shall be a minimum of 6-hours.
- B. Maximum number of students to be (6).
 1. Training materials shall be provided to all students.
- C. Record, label, and catalog all training on DVD Videodiscs. Provide discs to Owner for future in-house training sessions and / or reviews. Furnish all temporary equipment necessary for taping all training sessions. Maintain accurate and up-to-date time sheets of all training sessions.
- D. Contractor shall be on call during Warranty period to answer any questions Owner might have. The Owner reserves the right to use any excess training hours, not used by time of system completion, for future training as requested by Owner until total number of training hours has been completed.

3.08 DOCUMENTATION

- A. All Owners manuals and or maintenance information shall be provided in printed form as well as electronic PDF format to the owner and owner representative.

3.09 WARRANTY AND SUPPORT

- A. Unless otherwise noted, Contractor shall guarantee all materials, equipment, etc., five (5) years from date of final Owner acceptance of system. This guarantee shall include all labor, material and travel time.
- B. Contractor/Integrator and/or manufacturer(s) of system equipment must offer:
 - 1. Technical Support Capabilities (Technician onsite) response time onsite within 4 hours, 24- hours/7-days per week (“24/7”), and 365 days per year.
 - 2. 24-hour turn-around (from receipt of item) for Repair or Replacement of failed components, 7-days per week.

END OF SECTION

SECTION 283111 - DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Refer to Division 26 Section 26 05 01.00 "Common Requirements for Electric". Comply with applicable requirements therein.
- C. Refer to Division 26 Section 26 05 02.00 "Common Electric Materials and Methods". Comply with applicable requirements therein.
- D. Refer to Division 26 Section 26 05 05.00 "Existing Conditions". Comply with applicable requirements therein.
- E. Refer to Division 26 Section 26 05 19.00 "Low-Voltage Electrical Power Conductors and Cables". Comply with applicable requirements therein.
- F. Refer to Division 26 Section 26 05 26.00 "Grounding and Bonding for Electrical Systems". Comply with applicable requirements therein.
- G. Refer to Division 26 Section 26 05 29.00 "Hangers and Supports". Comply with applicable requirements therein.
- H. Refer to Division 26 Section 26 05 33.00 "Raceways and Boxes for Electrical Systems". Comply with applicable requirements therein.
- I. Refer to Division 26 Section 26 05 53.00 "Identification for Electrical Systems". Comply with applicable requirements therein.

1.2 SPECIAL CONDITIONS

- A. Owner's representative or engineer may relocate devices or equipment prior to installation within a 15 foot limit at no additional charge.
- B. Complete work, or part(s) thereof, at such time as may be designated by the owner's representative, so that it can be used for temporary or permanent use. Do not construe such use of the system as an acceptance of same by Owner.
- C. All components of system shall be RFI shielded to prevent false alarms.

- D. System shall not produce false alarms when subjected to power line transients and carrier signals. Two common power line carrier frequencies used by the University are the 2340 Hz. clock synchronizing signal and the 3218 Hz. bell ringing signal.

1.3 SUMMARY

A. Fire Alarm System Design:

- 1. Provide the final Fire Alarm System design completed by an approved and certified Fire Alarm System contractor, who shall coordinate the final design with all national and local codes, regulations and authorities having jurisdiction (AHJ), prior to furnishing Fire Alarm System submittals. Receipt of submittals by the project design professional shall be taken to mean that all such coordination has occurred.

B. Section Includes:

- 1. Provide complete and working Fire Protective Signaling System (NFPA 72) suitable for type of occupancy as defined by Local Building Code and as approved by local Fire Marshall or equivalent authority having jurisdiction (AHJ).
 - a. Fire-alarm control unit.
 - b. Manual fire-alarm boxes.
 - c. System smoke detectors.
 - d. Notification appliances.
 - e. Remote annunciator.
 - f. Addressable interface device.
 - g. Digital alarm communicator transmitter.

C. Work Included:

- 1. Provide equipment;
- 2. Provide wiring, connectors, and device plates;
- 3. Provide custom programming of all supplied programmable equipment;
- 4. Provide detailed installation-level engineering documentation;
- 5. Provide system commissioning, testing, warranty and training.

1.4 DEFINITIONS

- A. LED: Light-emitting diode.
- B. NICET: National Institute for Certification in Engineering Technologies.

1.5 SYSTEM DESCRIPTION

- A. Provide a complete multiplexed intelligent addressable fire alarm system throughout the building as shown on the drawings and in accordance with NFPA 72 and all authorities having jurisdiction. All equipment shall be UL listed.

- B. Each smoke detector shall be intelligent/addressable for the exact location in the building, capable of giving a print out of the sensitivity and have a sensitivity adjustment remotely from the console. This sensitivity shall also be adjusted automatically from the system clock if the user wishes changes during a 24-hour period. The system shall use analog data transmission in order to accomplish the previous requirements.
- C. Manual stations, sprinkler devices and all other "contact only" closing devices shall be Addressable.
- D. An Addressable only system will not be acceptable.
- E. Provide minimum 25% spare capacity for each data loop.
- F. Provide minimum 25% spare capacity for each alarm-indicating circuit.

1.6 REFERENCES

- A. Current applicable provisions of the following standards:
 - 1. National Fire Protection Standards
 - a. Central Station Signaling Systems-Protected Premises Unit, NFPA 71
 - b. National Fire Alarm Code, NFPA 72
 - c. Automatic Fire Detectors, NFPA 72
 - d. Life Safety Code, NFPA 101
 - 2. National Electric Code (including Article 760)
 - 3. Local and State building codes
 - 4. All requirements of the Local Authority Having Jurisdiction (AHJ)
 - 5. Provide system and components that are listed by Underwriters Laboratories, Inc. for use in Fire Protective Signaling Systems under the following standards as applicable:
 - a. Control Units for Fire Protective Signaling Systems (including UUKL sublisting), UL 864
 - b. Smoke Detectors for Fire Protective Signaling Systems, UL 268
 - c. Smoke Detectors for Duct Applications, UL 268A
 - d. Smoke Detectors, Single and Multiple Stations, UL 217
 - e. Heat Detectors for Fire Protective Signaling Systems, UL 521
 - f. Door Closers-Holders for Fire Protective Signaling Systems, UL 228
 - g. Audible Signaling Appliances, UL 464
 - h. Visual Signaling Appliances, UL 1638
 - i. Visual Notification Appliances / Signaling Devices for the Hearing Impaired, UL 1971
 - j. Manually Actuated Signaling Boxes, UL 38
 - k. Waterflow Indicators for Fire Protective Signaling Systems, UL 346
 - l. Power Supplies for Fire Protective Signaling Systems, UL 1481

1.7 PERFORMANCE REQUIREMENTS

- A. Be able to demonstrate through valid references and other means determined necessary by the Design Professional that the installing entity has completed at least 25 systems successfully. Upon request, provide detailed information on these reference systems within 16 business hours of request. Reference systems shall be of like type and scope to that specified herein.
- B. Provide the assistance of manufacturer/factory personnel as needed to assist in the programming, technical review of work being performed, as well as in commissioning of the systems and resolutions of problems arising during the course of the project.

1.8 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated with catalog numbers listed for each product.
- B. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
 - 2. Include voltage drop calculations for notification appliance circuits.
 - 3. Include battery-size calculations.
 - 4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 - 5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
 - 6. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
 - 7. Include calculations showing adequate capacity of the standby batteries as required by prevailing codes.
 - 8. Provide point-to-point wiring drawings that include the full part number/model number of every piece of equipment to be integrated into the system(s). Fully and clearly identify every point of signal, even in cases where not all connection points are used.
 - 9. Provide shop drawing portion of the submittal that is "installation-level" and "manufacturer-level" documentation, as applicable. It shall be complete and include all information necessary for the fabrication of custom items (parts lists, material types, dimensions, finish, color, labeling, etc.), wire labeling types and details, signal termination details, physical mounting details of equipment, as well as scaled drawings of all types necessary for special and spatial coordination.
 - 10. Include floor plans to indicate final outlet locations showing address of each addressable device. Show cable types, and size and route of cable and conduits.
- C. General Submittal Requirements:

1. Pay applicable inspection fees and provide all necessary product data submittals, shop drawing submittals, working drawings, supervision, etc. Have submittals approved in writing by the AHJ(s) prior to submittal to Engineer for review. Submit copies of this information to the Engineer with submittals.
2. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design, and licensed and certified by authorities having jurisdiction.
 - b. Provide a complete set of floor plan drawings showing conduit sizes (3/4" minimum) and number of conductors required to all components plus detailed wiring connections required at each type of device. Provide detailed submittals clearly showing the intended location of all field devices and their connections to the system. Prepare submittals utilizing AutoCad Release 2004 or higher Computer Aided Drafting System. Do not resubmit the Design Professional's drawings for submittal purposes. The Design Professional's drawings, in coordination with the specification, are intended to communicate scope, quality, capability, performance, functionality, and where appropriate, spatial intent. Provide preparation of Installation-level detailed shop drawings.

1.9 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Provide complete documentation for the Fire Alarm/Life Safety System showing the Model Number, type, rating, size, style, Manufacturer's Names, and Manufacturer's Catalog Data Sheets for all items to ensure compliance with these specifications.
- C. Notify the Authority Having Jurisdiction (AHJ) prior to installation or alteration of equipment and wiring.

1.10 CLOSEOUT SUBMITTALS

- A. Refer to Section 017823 "Operation and Maintenance Data"

1.11 MAINTENANCE MATERIAL SUBMITTALS

- A. Maintenance Data
 1. Submit maintenance data and parts lists for each type of fire alarm equipment installed, including furnished specialties and accessories. Include this data, product data, and shop drawings in maintenance manual.

1.12 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed Fire Alarm Certificate Corporation.

1.13 SOFTWARE SERVICE AGREEMENT

- 1. Comply with UL 864.
- 2. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- 3. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
- 4. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.14 PERIOD OF CORRECTION (AKA WARRANTY)

- A. Provide the owner with a one (1) year service contract. Indicate the cost of renewing this contract for an additional one, two and three year period at the owner's option.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Do not presume that all equipment necessary to provide a complete and working system is fully enumerated within these specifications. Use these specifications in conjunction with the information provided in the drawings to conclude the requirements and intent. If a conflict arises between these specifications and the drawings, the higher quality, higher quantity, and more stringent requirement shall apply.
- B. Provide all specified items, plus all incidentals and required items necessary to provide a complete and working system, installed in a professional manner, and in accordance with applicable codes and industry accepted "best practices".

- C. Where specified brands and models are listed on the drawings, interpret so that these products set the Standard-of-Quality that represents the characteristics, and minimum performance and feature-set considered acceptable. Where approved manufacturers are listed, interpret only to mean that the supplier/installer may select and use a product from the list of alternate manufacturers that either by itself, or in combination with other projects, meets or exceeds all specifications and capabilities of the product listed. Do not interpret to mean that the approved alternate manufacturer has a single product that is an exact equal in its product line.
- D. Be aware of physical characteristics, including size, of the products listed as the Standard of Quality. Additional costs, if any, associated with the approved use of an alternate product is the exclusive responsibility of the supplier/installer, including but not limited to additional costs incurred by the project's Design team and construction trades working on the projects.

2.2 MANUFACTURERS

- A. Fire alarm system shall be manufactured by Simplex, Notifier or Edwards. Simplex part numbers are provided in this spec for clarification only and do not exclude equivalent part numbers of acceptable manufacturers.

2.3 SYSTEMS OPERATIONAL DESCRIPTION

- A. Actuation of any alarm initiating device (except for duct smoke detectors) shall cause all audible, visual, and audio/visual alarm devices to operate continuously until acknowledged or reset. Actuation of duct smoke detectors shall send a supervisory signal to the central receiving station only.
- B. Actuation of any alarm initiating device (except for duct smoke detectors) shall automatically cause the following operations where applicable:
 - 1. Release all magnetically held doors.
 - 2. Shut down or reroute air handling systems according to established plans.
 - 3. Flash lamps located by each signal.
 - 4. Lower fire curtains.
 - 5. Close fire dampers.
 - 6. Indicate on remote annunciators.
 - 7. Duct smoke detectors shall shut down or reroute "associated" air handling systems according to established plans and shall send a supervisory signal to the central station.
- C. Note: The previous operations shall automatically be restored to normal pre-alarm state when the F.A. Control Panel is reset.
- D. System shall operate auxiliary pair of relay contacts for remote connection to a Central Station Monitoring System in accordance with the UK Central Station Fire Alarm System Connection Standard No. 16720S02.

- E. The general alarm devices may be silenced by authorized personnel only by entering a locked control cabinet and operating the proper silencing switch. Operation of this switch shall be indicated by a trouble light and audible signal.

2.4 ZONING

- A. Alarm initiating devices shall be grouped in zones in accordance with the Kentucky Building Code and the UK authority having jurisdiction (UK Fire Marshall).
- B. A zone in alarm shall be indicated by a lighted red LED on the zone module involved.
- C. A zone in trouble shall be indicated by a lighted yellow LED on the zone module involved.
- D. Provide dedicated zones connected to all existing and new suppression systems including but not limited to one for each Halon System, CO2 System, Sprinkler Branch Paddle Switch, and Sprinkler Common Water Gong Pressure Switch. Sprinkler zones shall supervise the tamper switch on all valves serving heads in that zone. Sprinkler common alarm zone shall supervise the PIV valve(s).

2.5 EQUIPMENT

- A. Control Panel 2001/8001
 - 1. Control panel shall have a minimum of 20 zone positions with a minimum of 2 spare equipped zones and 2 spare unequipped positions specifically designated for zone expansion to 20 fully equipped identical zones. Fire alarm panel shall be black with red trim unless otherwise specified. Fire alarm panel finish shall be manufacturer applied primer with baked on enamel finish. If the fire alarm is being installed for only part of a building and potential for expansion is indicated, install a control panel with a minimum of 30 possible zone positions. On Fire Alarm and Voice systems, provide mike and a phone line interface for dial up paging. Fire alarm system shall consist of the following modules:
- B. Control Module 2001 1007
 - 1. The control module provides a central location for the operating and indicating functions of the fire alarm system. These functions include system reset, alarm lock in, alarm resound acknowledge switch, earth LED, system and zone trouble LED, annunciator trouble LED, tone alert, and LED test. All status changes within the system are reported to this module. The information is then processed and transmitted to the appropriate module(s) for disposition.
 - 2. The 2001 1007 control module is provided with alarm resound. Upon having detected an alarm condition, a zone will report its status to the control module. This alarm condition will cause the alarm LED on the zone to flash at a rate of approximately 150 pulses per minute. Depending upon system operation, it will also cause the sound of alarm signals, the activation of the Central Station connection module, and the operation of the fan

control relays. When the acknowledge switch is depressed, the zone's alarm LED will cease to flash and remain illuminated. At this time, the signals will also be silenced. The activation of another zone repeats the entire alarm process, thus causing the signals to "resound".

C. Box Circuit Zone Module 2001 1017

1. The alarm initiating circuit module(s) shall provide electrically supervised normally open circuits monitoring for alarm (shorts), troubles (opens), and ground faults. The module shall provide alarm and trouble LED's per zone and auxiliary alarm contacts (N/O: 2.0 A Resistive) per zone. It shall allow the mixing of smoke detectors, heat detectors, flow switches, and other initiation devices on the same zone without the use of limiting resistors at manual stations and heat detectors and without using a separate source of power for the detectors.
2. The module shall be completely pluggable for ease of servicing and inherently Power Limited (Limited Energy) with a 100 ohm maximum line resistance. Provide zones as shown on plans plus spare zones for future use.

D. Signal Circuit Module 2001 2076

1. Signal circuit pluggable modules shall be supplied which are capable of supplying 2 amperes of signal capacity of either AC or DC power. It shall supply power via a 2 wire supervised circuit and indicate open or shorted faults on module front by illuminating LED and providing output to system trouble circuit. This module shall be protected by a visible and accessible fuse on module front. Alarm inputs of the common and individual type shall be furnished. Provide number of signal circuit modules required.

E. Relay Module 2001 3006

1. Pluggable relays and their bases complete with terminals for contractor wiring, shall be furnished for control of external equipment. Each relay shall be 4PDT and operate on 24VDC in and 120 VAC out. Contacts shall be rated at 2 amps minimum.

F. March Time Coder Module 2001 3044

1. A dual rate march time module shall be furnished which will provide approximately 20 beats/minute for pre signal and approximately 120 beats/minute for march time general alarm. The module shall include an LED which flashes at the selected code rate. This unit shall be used for flashing lamp operation.

G. Battery Charger Module 2001 3002

1. An automatic dual rate battery charger shall be installed in the control panel which shall be capable of charging either a Gel or Wet Cell battery. A constant trickle charge shall continuously be applied to the battery in order to maintain it at a full charge state. A method of adjusting the trickle charge rate shall also be provided in order to supply the selected battery with the exact charge rate it requires. In the event of a failure of the charger, the charger failure LED shall illuminate. Should the battery capacity drop below

specified limits, the charger shall automatically change to high rate condition and an LED shall illuminate.

H. Power Supply Module 2001 3021

1. A power supply module shall be furnished supplying 5 amperes (minimum) of continuous filtered power, or 8 amperes intermittent (minimum), of the proper voltage. The power supply shall be capable of furnishing the system power and power for devices such as smoke detectors, auxiliary relays, door holders, etc. It shall contain a normal power LED, battery trouble LED and power supply trouble LED, all viewable on front of enclosure. Capability of connecting a voltage regulator shall be included.

I. Batteries

1. Sealed batteries shall be type 2001 Maintenance Free and shall provide twenty four (24) hour stand by power.

J. Control Panel Cabinet

1. Control Panel Cabinets shall be comprised of an outer hinged door with a full size tempered glass viewing window. The glass door allows a complete view of all labels, indicating lights and switches. Cabinet shall be tamper resistant, locked enclosure which can be mounted in easy to reach public areas such as lobbies or corridors. Install cabinet at Firemen's designated entrance as approved by the UK Authority Having Jurisdiction, (UK Fire Marshall). Flush mount unless otherwise noted.

K. Field Installed Auxiliary Relays and Modules

1. All relays added to any standard fire alarm panel or auxiliary panel shall be UL listed plug in type with mounting bases installed and wired for every existing and initial installation spare zone provided or equitable.
2. Provisions shall be made to test all equipped and equitable spare positions for alarm, annunciation, and supervision, during the final acceptance testing of all new and renovated fire alarm systems.

L. REMOTE ANNUNCIATOR

1. Provide only when design is such that the Main Fire Alarm Control Panel (FACP) cannot be located near the designated entrance to provide all required annunciation or more than one annunciator is required. Remote annunciator shall be completely free from screws or other fastenings on its face to prevent tampering and shall be cut keyed to match the FACP. At minimum, the main FACP common alarm and trouble and the alarm and trouble for each zone shall be annunciated on the remote annunciator. LED labels shall be permanent, professionally made and shall meet UK Construction Administrators approval. Unit shall be flush mounted, factory baked on black enamel with red trim and shall be complete with trouble LEDs and internally mounted silence and reset switches.
2. Where specified, remote annunciator for director's office shall be single zone with indicator lamp, buzzer and silence switch. Simplex No. 4308 or equal.

3. Horn and Flashing Lamp Units shall be of the following type:
 - a. 2903 9002 Audio Visual Units
 - b. 2901 9833,9806 HORNS
 - c. 2905 9960 TRIM FOR AUDIO VISUAL UNITS
 - d. 2975 9145 BOXES FOR AUDIO VISUAL UNITS
4. Alarm horn shall be 2901 9806 and mount on a common plate with the lamp unit. The unit shall be flush and installed where shown on plans. Provide 180 degree sound direction deflectors on all horns unless otherwise specified.
5. In special animal areas, horns of variable volume and/or tone shall be supplied.
6. In sleeping rooms, provide individual piezo horns or speakers in each room.
7. Provide horn or speaker levels in accordance with NFPA. Design with consideration for sound proofing as a result of fire rated walls or other reasons.
8. Provide at least two (2) signal devices on each level of building.
9. No signal devices are required in storage rooms.

M. AREA SMOKE/HEAT DETECTORS

1. Furnish and install where indicated on the plans, photo electric smoke detectors, type 2098 9525 base equipped with a 2098 9400 detector head. The detectors shall be interchangeable and compatible with ionization detectors using the same type bases. Their light source shall be a pulsed infrared LED for low power consumption under standby conditions at 24Vdc. An installed detector smoke chamber shall require only 15 seconds disassembly time to make all components readily accessible for cleaning as required for routine maintenance and test. Detectors shall have detector screens to prevent rodents and insects, large enough to cause a false alarm, from entering the detection chamber. Detector circuit and wiring shall be sealed base construction such that moisture condensing in or entering conduit junction box shall not contaminate detector or cause false alarms.
2. Nominal detector sensitivity shall be 1.4% per foot obscuration with a range of 1% to 1.84%. Regardless of sensitivity setting, the detector's stability shall be unaffected by high air velocity. The detector shall be capable of operating on either a 2 wire loop with end of line resistor or on a 4 wire loop using 24VDC.

N. MISCELLANEOUS SMOKE/HEAT DETECTORS

1. Corridors: Install area smoke/heat detectors in accordance with this UK Standard.

O. HEAT DETECTORS

1. All heat detectors shall be combination rate of rise/136 degrees F. fixed temperature, unless special applications of the areas require other types heat detectors as noted below. All heat detectors shall be equipped with a LED that latches on alarm. Use listed spacing of smoke detectors for all heat detectors to guarantee code compliance should the heat detectors be replaced with spot type smoke detectors in the future.

P. MISCELLANEOUS HEAT DETECTORS

1. Office areas: Install combination 135 degree F. fixed temperature/rate of rise detectors with latching LED on alarm.
2. General Storage Areas: Install heat detectors in general storage areas.
3. Mechanical Rooms: Install 135 degree fixed temperature heat detector with latching LED if nominal room temperature is below 135 degree F.

Q. OTHER AREA DETECTORS

R. BUILDING MAP(S)

1. Building map(s) shall be provided adjacent to the main and remote annunciator panel(s) and shall consist of floor plans inked on mylar with color coded zones. Zone indications shall depict the exact zone number and alphanumeric labeling as shown on the FACP zone labels. Building map shall be a detailed floor plan with all room numbers, fire alarm zones, detectors, horns, alarm initiators, flow switches, sprinkler heads, sprinkler zones, and all other devices shown. "Zone No." shall be in 1/4" high letters. Maps shall be properly oriented and shall be 1/16" = 1' scale or 1/32' = 1' scale with written exception of the owner. Provide durable aluminum frames and all required mounting hardware and mount where indicated on plans. Aluminum frame must be such that it can be removed, disassembled and reassembled to allow replacement or revisions to the mylar. The layers of the map in the frame from back of the frame to the front of the frame shall be as follows:
 - a. 1/8" Plexiglas
 - b. white backing mat
 - c. pastel backing color layers for zones
 - d. inked mylar with floor plan, room #s, fire alarm zones, detectors, horns, alarm initiators, flow switches, sprinkler heads, sprinkler zones, and all other devices.
 - e. Spacer mat to allow mylar to be suspended from top of frame and reduce washboarding
 - f. 1/8" ultraviolet blocking plexiglass
 - g. 1/8" clear lexan to prevent scratching
2. Building map(s) shall be installed, complete with "as built" corrections before system is left in operation and before the University will consider the project for substantial completion. Before this systems is left operational and reports to the UK Central Station, this map(s) must be in place.

S. MANUAL STATIONS

1. Manual Stations shall be type 2099 9201, flush mounted. A downward pull of the level shall activate a positive snap action switch. The station shall remain activated until reset by means of a cut key. A red surface box shall be furnished for all surface mounted stations.

PART 3 - EXECUTION

3.1 GENERAL

- A. The work performed under this section shall be conducted by a team of qualified individuals.

3.2 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72 for installation of fire-alarm equipment.
- B. In addition to specific instructions provided herein, complete system must be installed in accordance with all applicable sections of the U.K. Construction Standards No. 00000S01 16999SXX
- C. The contractor shall furnish and install in accordance with manufacturer's instructions, all wiring, conduit, and outlet boxes required for the installation of a complete system as described herein and shown on the architect's plans.
- D. All wiring shall meet the requirements of the national, state, and local electrical codes. The sizes of different wires shall be those specified by the manufacturer or larger as specified in this standard. Color codes shall be used where specified. All wires shall test free from ground and crosses between equipment. Final connections of the control panel shall be made under direct supervision of a representative of the manufacturer.
- E. Smoke detectors are not to be mounted within three feet of air outlets.
- F. In cases where a detector is installed in a room or closet, the detector shall be mounted as close as possible to the center of the room unless written exception is obtained from the University D&C Division. One exception, when room has a door opening into a shower or bath, mount the detector as far away from that room door as the code permits to reduce potential false alarms.
- G. Mount wall mounted smoke detectors per NFPA, *Note: normally a minimum of 6 and a maximum of 12 inches from the ceiling to the top of the detector.
- H. Smoke detectors to be installed on either side of a set of fire doors should be mounted no more than five feet and no less than twelve inches from the wall section above the door.
- I. Visuals should not be obscured by support beams or protrusions on walls. Visuals should not be mounted within three feet of wall mounted lights.
- J. Do not power up system until Manufacturer Field Representative is present.
- K. Minimum conduit size is 3/4".

- L. Metal raceway used in exterior locations shall be aluminum as manufactured by Wiremold or equivalent unless written exception is obtained from the UK D&C Division.
- M. Loads greater than 10 AMPS (for auxiliary functions) shall not be run in conduit with other circuits.
- N. Manual Stations shall be installed not more than 4 feet from the floor and five feet from exit or door.
- O. Metal components of system shall be grounded. Do not use the conduit as a grounding system for equipment, cabinets or devices. Pull separate grounds wires for this application.
- P. Do not use ceiling wire hangers or wire supports to support any equipment or conduit added on this project.
- Q. Provide an isolated run of conduit from the 120 VAC power source to the Fire Alarm Panel. If an existing system is being replaced and the existing power is being reused, it is the responsibility of the provider to isolate or verify isolation of the existing 120 VAC power run(s)
- R. Do not run any 120 VAC wiring with any DC wiring.

3.3 CONDUIT LOCATION, APPEARANCE AND SUPPORT

- A. All conduit shall be concealed except in University of Kentucky designated mechanical rooms or unless otherwise specified and shown on drawings approved by the UK D&C Division. Conduits which are not concealed must have written approval of the UK D&C Division prior to installation and shall be surface metal raceway (wiremold) unless otherwise noted in the approval. Conduit or tubing shall have supports installed and spaced in accordance with the NEC. Conduit shall be installed with runs parallel or perpendicular to walls, structural members on intersections of vertical planes and ceilings, with right angle turns consisting of cast metal fittings or symmetrical bends. Bends or offsets shall be avoided where possible but where necessary shall be made with approved conduit bending machine. Conduit or tubing which has been crushed or deformed in any way shall not be installed.

B. INSTALLER CERTIFICATION

- 1. This system must be installed under the supervision of a person certified to install fire alarm systems in the State of Kentucky. All submittals for this project shall list the name, license number, and telephone number(s) of one person with this certification and who is assigned to represent the vendor before, during and after this installation.

C. INSPECTION AND TESTING

1. Installer shall provide a certified fire alarm inspector for final checkout and test of every devices. Checkout to include checkout of wiring to ensure compatibility with the system and proper operation of every device (alarm and trouble reporting).
2. Installer shall provide final checkout certification letter and inspection reports to UK Construction Administrator.

D. EQUIPMENT REMOVAL AND SALVAGE

1. All removed equipment shall be returned to the U.K. Physical Plant unless proposed disposition is discussed and a written exception is included in the specifications.
2. Removed equipment will be accepted by U.K. at a mutually agreeable acceptance time.
3. Do not use vacated equipment enclosures as junction boxes unless this proposed reuse of equipment is specified in writing under a heading of "Special Conditions".

E. INTERRUPTION OF SERVICE

1. Any interruption of service of existing Fire Alarm Systems must be authorized in writing by the U.K. Fire Marshall or his/her appointed representative prior to project start, otherwise, the University will assume that existing systems will remain 100% operational at all times and will only have one zone or signal circuit out of service at any time. The maximum down time for any part of the system is 1 hour unless otherwise specified in writing.
2. If problems develop and system cannot be kept operational as this section specifies, contact the U.K. Fire Marshall for his/her recommendation. If the U.K. Fire Marshall request security guard(s) be put on duty until system is back into operation, this will be done at the expense of the contractor.

F. SYSTEM GUARANTEE

1. System guarantee shall be in accordance with UK Standard 01740S01

G. WIRING LEGEND

Section 1.01 *CIRCUITS WIRE SIZE-AWG WIRE COLOR EOL Value*

(Unless Otherwise Specified)

ALARM CIRCUITS WIRES	# 18	ORANGE(pos.)	3.3KOHM
Stations		BLUE(negative)	
Smoke Detectors			
Heat Detectors			
Waterflow Switch			
Tamper Switch-Tbl Only			
TRouble CIRCUIT WIRING	# 18	BROWN	
COMMON ANNUNCIATOR WIRES	# 18	VIOLET	
POINT ANNUNCIATOR WIRES	# 18	PINK WITH BRADY TAG	
120VAC WIRING	# 12	BLACK	

24VDC	# 14	WHITE (Neutral) RED (Positive) BLACK (Negative)	
PARALLEL SIGNAL WIRES	# 14	RED (Positive) BLACK (Negative)	15K OHM
SERIES SIGNAL WIRES	# 14	YELLOW	NONE
DOOR HOLDER	# 14	BLUE WHITE (Neutral)	
FAN SHUT DOWN WIRES	# 14	SELECTED BY CONTRACTOR	
ELEVATOR CONTROL WIRES	# 14	SELECTED BY CONTRACTOR	
TELEPHONE WIRES	# 22	TWISTED/SHIELDED	22K OHM
SPEAKER WIRES	# 18	TWISTED	15K OHM

Notes

1. All wire shall be stranded, tinned copper unless otherwise indicated.
2. All shielding is tinned copper braid with additional aluminum sheath unless otherwise noted.
3. All wiring for data lines and voice risers must be Belden 9574, or an equivalent unless otherwise noted on drawings.

END OF SECTION 283111

Submittal Form – 263111.00 – Digital, Addressable Fire Alarm System

Provide And Complete This Sheet And Submit As A Cover Sheet For Submittals Requested Within This Section.

Electrical Contractor: _____ Electrical Supplier: _____

Electrical Contractor Rep: _____ Electrical Supplier Rep: _____

Electric Contractor Ph. Number: _____ Electric Supplier Ph. Number: _____

Electric Contractor Rep Email: _____ Electric Supplier Rep Email: _____

Submitted Manufacturers (List Type And Manufacturer):		

	Yes	No
Manufacturers Listed As Basis Of Design Or Listed Equivalent Manufacturers?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Manufacturers' Qualifications Meet Or Exceed Those Required Under Quality Assurance Section Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Manufacturers' Warranty Meets Or Exceeds The Warranty Period Specified Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Submitted Components Meet All Requirements Listed Within This Specification?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Product Data Is Included For Each Component?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Coverage And Candela Requirements For All Visible Notification Appliances Have Been Checked And Devices Shown On Shop Drawings Accordingly?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Battery Calculations Are Included?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		
Project-Specific Shop Drawings Are Included For All Plan-View Areas?	<input type="checkbox"/>	<input type="checkbox"/>
If No, Explain _____		

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For each exposed product and for each color and texture specified.
- C. Other Action Submittals:
 - 1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.2 QUALITY ASSURANCE

- A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- B. ACI Publications: Comply with ACI 301 unless otherwise indicated.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.
- C. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
- D. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.
- E. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.
- F. Deformed-Steel Wire: ASTM A 496/A 496M.
- G. Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating. Cut bars true to length with ends square and free of burrs.

- H. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified.

2.2 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:
 - 1. Portland Cement: ASTM C 150, white portland cement Type I.
 - a. Fly Ash: ASTM C 618, Class C or Class F.
- B. Normal-Weight Aggregates: ASTM C 33, Class 4S, uniformly graded. Provide aggregates from a single source.
- C. Water: Potable and complying with ASTM C 94/C 94M.
- D. Air-Entraining Admixture: ASTM C 260.
- E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

2.3 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
- F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

2.4 RELATED MATERIALS

- A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber in preformed strips.

2.5 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, with the following properties:
 - 1. Compressive Strength (28 Days): 4000 psi.
 - 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.
 - 3. Slump Limit: 3 inches, plus or minus 1 inch.
 - 4. Air Content: 5-1/2 percent plus or minus 1.5 percent.
- B. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

2.6 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
- B. Remove loose material from compacted subbase surface immediately before placing concrete.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.3 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

3.4 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness:
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.5 CONCRETE PLACEMENT

- A. Moisten subbase to provide a uniform dampened condition at time concrete is placed.
- B. Comply with ACI 301 requirements for measuring, mixing, transporting, placing, and consolidating concrete.
- C. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- D. Screed paving surface with a straightedge and strike off.
- E. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.6 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
 - 1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
 - 2. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.7 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound or a combination of these.

3.8 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
 - 1. Elevation: 3/4 inch.
 - 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
 - 3. Surface: Gap below 10-foot- long, unlevelled straightedge not to exceed 1/2 inch.
 - 4. Joint Spacing: 3 inches.
 - 5. Contraction Joint Depth: Plus 1/4 inch, no minus.
 - 6. Joint Width: Plus 1/8 inch, no minus.

3.9 PAVEMENT MARKING

- A. Allow concrete paving to cure for a minimum of 28 days and be dry before starting pavement marking.
- B. Sweep and clean surface to eliminate loose material and dust.
- C. Apply paint with mechanical equipment to produce markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.10 REPAIRS AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

- B. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- C. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 323113- VINYL COATED CHAIN LINK FENCING AND GATES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Furnish and install all chain link fencing and gates.

1.2 SUBMITTALS

- A. Changes in specifications may not be made after the bid date.
- B. Shop drawings: Layout of fences, gates with dimensions, details, and finishes of components, accessories, and post foundations.
- C. Product data: Manufacturer's catalog cuts indicating material compliance and specified options.
- D. Samples: If requested, samples of materials (e.g., fabric, wires, and accessories).

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Products from qualified manufacturers having a minimum of five years experience manufacturing thermally fused chain link fencing will be acceptable by the Owner's Representative as equal if they meet the following specifications for design, size gauge of metal parts and fabrication.
- B. Approved Manufacturer: AMERISTAR or equivalent.

2.2 CHAIN LINK FENCE FABRIC

- A. Woven with nine (9) gauge steel wire or aluminized coated steel wire.
- B. Zinc coated steel fabric shall be galvanized after weaving and conform to ASTM-A-392. Galvanizing shall be 2.0 oz./s.f. minimum.
- C. Aluminum coated steel fabric shall conform to ASTM-A-428 and be 40 ounces per square foot minimum.
- D. Fabric to be woven in 2" mesh (baseball fields) with top selvage knuckled and bottom selvage barbed
- E. Fabric height as shown on the drawings.
- F. Fabric to have a 7 mil coating of Polyvinyl Chloride Bond to the fabric by utilizing the fusion method.

- G. The vinyl coating shall have a specific gravity of 1.34, be evenly applied and free of blisters. The bond between the vinyl coating and the steel fabric to be equal or greater than the cohesive strength of the vinyl.
- H. The minimum break strength of the coated fabric shall be 800 pounds.
- I. Selvage of fabric knuckled at bottom.

2.3 STEEL FENCE FRAMING

- A. Steel pipe - Type I: ASTM F 1083, standard weight schedule 40 and SS40 for 27'-6" backstop posts: minimum yield strength of 25,000 psi (170 Mpa); sizes as indicated. Hot-dipped galvanized with minimum average 1.8 oz/ft² (550 g/m²) of coated surface area.
- B. Steel pipe - Type II: Cold formed and welded steel pipe complying with ASTM F 1043, Group IC, with minimum yield strength of 50,000 psi (344 Mpa), sizes as indicated. Protective coating per ASTM F 1043, external coating Type B, zinc with organic overcoat, 0.9 oz/ft² minimum zinc coating with chromate conversion coating and verifiable polymer film. Internal coating Type B, minimum 0.9 oz/ft² (275 g/m²) zinc or Type D, zinc pigmented, 81% nominal coating, minimum 3 mils (0.08 mm) thick.
- C. Formed steel ("C") sections: Roll formed steel shapes complying with ASTM F 1043, Group II, produced from 45,000 psi (310 Mpa) yield strength Steel; sizes as indicated. External coating per ASTM F 1043, Type A, minimum average 2.0 oz/ft² (610 g/m²) of zinc per ASTM A 123, or 4.0 oz/ft² (1220 g/m²) per ASTM A 525. C section post may have ASTM F 2043, Type C external and internal coating consisting of 0.9 oz/ft² (275 g/m²) zinc 5% aluminum-mischmetal alloy, per ASTM A 875.
- D. Steel square sections: ASTM A 500, Grade B Steel having minimum yield strength of 40,000 psi (275 Mpa); sizes as indicated. Hot-dipped galvanized with minimum 1.8 oz/ft² (550 g/m²) of coated surface area.
- E. End Corner and pull post 3" od Schedule 40 pipe weighing 5.79 per lineal feet.

Line (intermediate) Post 2-1/2" od Schedule 40 pipe weighing 4.10 lbs per lineal feet.

Rail and Braces 1-5/8" od 2.27 lbs/ft

2.4 CHAIN LINK SWING GATES

- A. Gate frames: Fabricate chain link swing gates in accordance with ASTM F 900 using galvanized steel tubular members, 2" square, weighing 2.72 lb/ft. Fusion or stainless steel welded connections forming rigid one-piece unit.
- B. Hardware materials: Hot dipped galvanized steel or malleable iron shapes to suit gate size.
- C. Hinges: Structurally capable of supporting gate leaf and allow opening and closing without binding. Non-lift-off type hinge design shall permit gate to swing 180° (3.14 rad) inward.
- D. Latch: Forked type capable of retaining gate in closed position and have provision for padlock. Latch shall permit operation from either side of gate.

- E. Keeper: Provide keeper for each gate leaf over 5' wide. Gate keeper shall consist of mechanical device for securing free end of gate when in full open position.
- F. Double gates: Provide drop rod to hold inactive leaf. Provide gate stop pipe to engage center drop rod. Provide locking device and padlock eyes as an integral part of latch, requiring one padlock for locking both gate leaves.
- G. Gate posts: Steel pipe ASTM F 1083 standard weight schedule 40; minimum yield strength of 25,000 psi (170 Mpa) or steel square sections (ASTM A 500, Grade B) having minimum yield strength of 40,000 psi (275) Mpa size as indicated. Hot-dipped galvanized with minimum 1.8 oz/ft² (550 kg/m²) of zinc or respective material finished in accordance with STM F 1043.

Gate leaf single width	Post Size (Square)	Weight
6 ft. or less	3 inch (3/16" wall)	5.1 lb/ft

- H. Brace and tension (stretcher bar) bands: Pressed steel. At square post provide tension bar clips.
- I. Tension (stretcher) bars: One piece lengths equal to 2 inches (50 mm) less than full height of fabric with a minimum cross-section of 3/16" x 3/4" (4.76 mm x 19 mm) or equivalent fiber glass rod. Provide tension (stretcher) bars where chain link fabric meets terminal; posts.
- J. Truss rods: Steel rods with minimum diameter of 5/16" (7.9 mm).
- K. Nuts and bolts are galvanized but not vinyl coated. Cans of PVC touch up paint are available to color coat nuts and bolts if desired.

2.5 SETTING MATERIALS

- A. Concrete: Minimum 28 day compressive strength of 3,000 psi (20 MPa).
- B. Drive Anchors: Galvanized angles, ASTM A 36 steel 1" x 1" x 30" (25 mm x 25 mm x 762 mm) galvanized shoe clamps to secure angles to posts.

2.6 PVC COLOR COATING

- A. All posts, rails, fabric, wires, braces, gates, and hardware used shall be PVC color coated: Black.
- B. PVC coating shall be applied to pipes and fittings by preheating the substrate, which has been cleaned and pretreated, having received a primer so as to thermally fuse and bond the PVC to the metallic.
- C. Finished product shall be smooth, clean and free from visual bubbles or pits.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify areas to receive fencing are completed to final grades and elevations.
- B. Ensure property lines and legal boundaries of work are clearly established.

3.2 CHAIN LINK FENCE FRAMING INSTALLATION

- A. Install chain link fence in accordance with ASTM F 567 and manufacturer's instructions.
- B. Locate terminal post at each fence termination and change in horizontal or vertical direction of 30 degrees or more.
- C. Space line posts uniformly at 10' on center or as indicated on the drawings.
- D. Concrete set all posts: Drill holes in firm, undisturbed or compacted soil. Holes shall have diameter 4 times greater than outside dimension of post, and depths approximately 6" deeper than post bottom. Excavate deeper as required for adequate support in soft and loose soils, and for posts with heavy lateral loads. Set post bottom 36" below surface when in firm, undisturbed soil. Place concrete around posts in a continuous pour. Trowel finish around post. Slope to direct water away from posts.
- E. Check each post for vertical and top alignment, and maintain in position during placement and finishing operations.
- F. Bracing: Install horizontal pipe brace at mid-height for fences 6' and over, on each side of terminal posts. Firmly attach with fittings. Install diagonal truss rods at these points. Adjust truss rod, ensuring posts remain plumb.
- G. Top rail: Install lengths, 21'-0". Connect joints with sleeves for rigid connections for expansion/contraction.

3.3 CHAIN LINK FABRIC INSTALLATION

- A. Fabric: Install fabric on interior side and attach so that fabric remains in tension after pulling force is released. Leave approximately 1" between finish grade and bottom selvage. Attach fabric with wire ties to line posts at 15" on center and to rails, braces, and bottom rail at 24" on center.
- B. Tension (stretcher) bars: Pull fabric taut; thread tension bar through fabric and attach to terminal posts with bands or clips spaced maximum of 15" on center.

3.4 CHAIN LINK SWING GATE POST INSTALLATION

- 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 diameter 4 times greater than outside dimension of post, and depths approximately 6" deeper than post bottom. Excavate deeper as required for adequate support in soft and loose soils,

and for posts with heavy lateral loads. Set post bottom 36" below surface when in firm, undisturbed soil. Place concrete around posts in a continuous pour. Trowel finish around post and slope to direct water away from posts.

1. Gate posts and hardware: Set keeper, stops, sleeves into concrete. Check each post for vertical and top alignment, and maintain in position during placement and finishing operations.

3.5 GATE INSTALLATION

- A. Install gates plumb, level, and secure for full opening without interference.
- B. Attach hardware by means which will prevent unauthorized removal.
- C. Adjust hardware for smooth operation.

3.6 ACCESSORIES

- A. Chain link fence accessories: Provide items required to complete fence system. Galvanized each ferrous metal item and finish to match framing.
- B. Post caps: Formed steel, cast malleable iron, or aluminum alloy weathertight closure cap for tubular posts. Provide one cap for each post. Cap to have provision for barbed wire when necessary. (Where top rail is used, provide tops to permit passage of top rail.)
- C. Top rail and brace rail ends: Formed steel, malleable or cast iron, for connection of rail and brace to terminal posts.
- D. Top rail sleeves: 6" sleeve allowing for expansion and contraction of top rail.
- E. Wire ties: 9 gauge 0.148" galvanized steel wire for attachment of fabric to line posts. Double wrap 13 gauge 0.092" for rails and braces. Hog ring ties of 12-1/2 gauge 0.0985" for attachment of fabric to tension wire.
- F. Tie wires: Bend ends of wire to minimize hazard to persons and clothing.
- G. Fasteners: Install nuts on side of fence opposite fabric side for added security.

3.7 CLEANING

- A. Clean up debris and unused material, and remove from the site.

END OF SECTION

