SECTION 00 01 01 PROJECT TITLE PAGE

PROJECT MANUAL

FOR

JJC - MAIN CAMPUS - STEAM PIPE SYSTEM REPLACEMENT WITH CONDENSING BOILERS 1215 HOUBOLT ROAD JOLIET, ILLINOIS 60431

OWNER

JOLIET JUNIOR COLLEGE 1215 HOUBOLT ROAD JOLIET, ILLINOIS 60431

ARCHITECT/ENGINEER

KLUBER ARCHITECTS + ENGINEERS 10 S. SHUMWAY AVE. BATAVIA, ILLINOIS 60510

END OF DOCUMENT

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GENERAL

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END OF DOCUMENT

SECTION 01 30 00 ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Submittals for review, information, and project closeout.
- B. Architect/Engineer-provided CAD files.
- C. Number of copies of Submittals.
- D. Submittal procedures.

1.02 RELATED REQUIREMENTS

- A. Section 01 70 00 Execution and Closeout Requirements: Additional coordination requirements.
- B. Section 01 78 00 Closeout Submittals: Project record documents; operation and maintenance data; warranties and bonds.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 Submittals FOR REVIEW

- A. When the following are specified in individual sections, submit them for review:
 - 1. Product data.
 - 2. Shop drawings.
- B. Submit to Architect/Engineer for review for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents.

3.02 Submittals FOR INFORMATION

- A. When the following are specified in individual sections, submit them for information:
 - 1. Design data.
 - 2. Certificates.
 - 3. Test reports.
 - 4. Inspection reports.
 - 5. Manufacturer's instructions.
 - 6. Manufacturer's field reports.
 - 7. Other types indicated.
- B. Submit for Architect/Engineer's knowledge as contract administrator or for Owner.

3.03 Submittals FOR PROJECT CLOSEOUT

- A. Submit Correction Punch List for Substantial Completion.
- B. Submit Final Correction Punch List for Substantial Completion.
- C. When the following are specified in individual sections, submit them at Project Closeout: 1. Project record documents.

- 2. Operation and maintenance data.
- 3. Warranties.
- 4. Bonds.
- 5. Other types as indicated.
- D. Submit for Owner's benefit during and after Project completion.

3.04 ARCHITECT/ENGINEER-PROVIDED CAD FILES

- A. After the execution of the Contract, Architect/Engineer will provide, free of charge, upon receipt of a properly completed and signed request utilizing "Electronic Data Transfer Consent Form" at the end of this Specification Section, CAD files depicting graphic information for the project as follows:
 - Architectural Floor Plans: Column grid, walls, floors, stairs, doors, windows, room numbers, ceiling grid, mechanical diffusers, plumbing fixtures, sprinkler heads (if depicted in Bid Documents) and lights.
- B. Contractor acknowledges and accepts that the Architectural Floor Plans do not contain structural, mechanical, electrical, plumbing, fire protection and other building systems information depicted in the Bidding Documents. Examples of information not contained in these files include, but are not limited to, title blocks, keynotes, schedules, mechanical ductwork and equipment, electrical device symbols, circuit numbers and home runs, plumbing equipment, piping runs and riser diagrams, and architectural/engineering text or details. No other CAD files, data or information will be provided.
- C. Only a request from The Contractor will be honored. Subcontractors must obtain the files from the Contractor.
- D. In submitting a request, Contractor acknowledges that:
 - 1. Architect/Engineer bears no responsibility for the data or its transmission,
 - 2. Use of the data by the Contractor or his Subcontractors in no way relieves the Contractor of his obligations under the Contract,
 - 3. Contractor is solely liable for any and all claims arising from any and all products generated by the Contractor or its Subcontractors employing the data,
 - 4. Contractor and its Subcontractors have a limited, non-exclusive license to use the data solely in connection with the Work of the Project, and that
 - 5. Architect/Engineer retains all rights, including copyright, to the data.

3.05 NUMBER OF COPIES OF Submittals

- A. Documents for Review:
 - 1. Small Size Sheets: Not Larger Than 11 x 17 inches. Submit 2 paper copies, one of which will be retained by Architect/Engineer. Contractor shall make his own copies from the original returned by the Architect.
 - a. Contractor's Option: In lieu of paper copies indicated above, submit in Adobe PDF electronic file format via email. Architect will return a reviewed copy in Adobe PDF electronic file format via email. Create PDFs at native size and right-side up; illegible files will be rejected.
 - 2. Large Size Sheets: Larger Than 11 x17 inches; 36 x 48 inches maximum. Submit 2 paper copies, one of which will be retained by Architect/Engineer. Electronic file format (PDF or other)

is NOT acceptable. Contractor shall make his own copies from the original returned by the Architect.

B. Documents for Information: Submit one copy.

3.06 Submittal PROCEDURES

- A. Shop Drawing Procedures:
 - 1. Prepare accurate, drawn-to-scale, original shop drawing documentation by interpreting the Contract Documents and coordinating related Work.
 - 2. Generic, non-project specific information submitted as shop drawings do not meet the requirements for shop drawings.
- B. Transmit each Submittal with a copy of approved Submittal form.
- C. Transmit each Submittal with AIA Form G810.
- D. Sequentially number the transmittal form. Revise Submittals with original number and a sequential alphabetic suffix.
- E. Identify Project, Contractor, Subcontractor or supplier; pertinent drawing and detail number, and specification section number, as appropriate on each copy.
- F. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of Products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with the requirements of the Work and Contract Documents.
- G. Deliver Submittals to Architect/Engineer at business address.
- H. Schedule Submittals to expedite the Project, and coordinate submission of related items.
- I. For each Submittal for review, allow 20 days excluding delivery time to and from the Contractor.
- J. Clearly identify variations from the Contract Documents. Regardless of the type of variation, Contractor is solely responsible for errors in the field that arise from Submittal variations from the requirements of the Contract Documents if those variations were not expressly noted to specifically identify for and describe to the reviewer the nature of the variation from the Contract Documents.
- K. Identify variations from Contract Documents and Product or system limitations that may be detrimental to successful performance of the completed Work.
- L. Correlate submitted items with specified products; clearly indicate the specified product that corresponds to each submitted item.
- M. When options or optional features available for a Product are indicated in a Submittal, and selections for those options/features are indicated in the Contract Documents, identify on the Submittal the selection indicated in the Contract Documents.
- N. Provide space for Contractor and Architect/Engineer review stamps.
- O. When revised for resubmission, using clouds, highlights or other means acceptable to the Architect, identify all changes made since previous submission. Resubmittals that do not clearly identify all changes may be delayed and/or returned to the Contractor unrevised.

- P. The Contractor is entitled to 1 Resubmittals of any Shop Drawing, Product Data, or Closeout Submittal item rejected by the Architect or returned by the Architect for further action. Thereafter, the Contractor shall pay the cost of all further Architect's reviews of Shop Drawing, Product Data or Closeout Submittal, at a rate of \$200.00/hour. Cost of such further reviews will be deducted from the Contract Sum by Change Order.
- Q. Distribute reviewed Submittals as appropriate. Instruct parties to promptly report any inability to comply with requirements.
- R. Submittals not requested will not be recognized or processed.
- S. Submittal reviews may be delayed and/or Submittals may be returned unrevised for any of the following reasons:
 - 1. Submittals submitted outside the scheduled dates of the Submittal Schedule.
 - 2. Submittals are incomplete or are missing information.
 - 3. Submittals are not submitted in accordance with procedures outlined in this Section (i.e. spec Section number not indicated, missing Contractor's review stamp, submitted items not correlated with specified products).



ELECTRONIC DATA TRANSFER CONSENT FORM

JJC - MAIN CAMPUS - STEAM PIPE SYSTEM REPLACEMENT WITH CONDENSING BOILERS Project Name: 1215 HOUBOLT ROAD JOLIET, IL 60431

Project No .: 17-292-1160

Owner: JOLIET JUNIOR COLLEGE

Your Work:

KLUBER, INC. (hereinafter referred to as "Kluber") an Illinois corporation, is providing electronic data to you solely at your request and for your convenience. By accepting and opening any of the electronic data files, you agree that Kluber bears no liability for the data or its transmission to you and that you are solely liable for any and all claims referring or relating to any and all products you, or your Subcontractors, may generate with the data.

You acknowledge that you have a limited non-exclusive license to use the information solely in connection with your work on the project captioned above, and that Kluber retains all rights, including copyright, to the data.

Acknowledged by: _ (Printed Name) (Signature) Company: Date: Email:

Architectural Floor Plans are transmitted for the contractors' use as backgrounds for shop drawings and as-built drawings, and, as such, contain graphic information for column grid, walls, floors, stairs, doors, windows, room numbers, ceiling grid, lights, diffusers and sprinkler heads where indicated on Bid Documents. Plans do not contain title blocks, keynotes, schedules, mechanical ductwork and equipment, electrical device symbols, circuit numbers and home runs, plumbing equipment, piping runs and riser diagrams, and architectural/engineering text and details. Plans depict entire floors and are not formatted, partial plans as depicted in the Bidding Documents. Files are provided in R2013 .DWG format.)

> Kane County Office 10 South Shumway Avenue Batavia, Illinois 60510 630.406.1213

Lake County Office Gurnee, Illinois 60031 Normal Illinois 61761 847.336.3428

McLean County Office 4212 Old Grand Ave., Ste. 101 108 E. Beaufort Street, Box 10 309.430.6460

SECTION 01 41 00 REGULATORY REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General.
- B. Definitions.
- C. Quality Assurance.
- D. Regulatory Requirements.

1.02 RELATED SECTIONS

A. Section 01 42 00 - References.

1.03 GENERAL

- A. Comply with all applicable laws, rules, regulations, codes and ordinances.
- B. If the Contractor observes that the Contract Documents may be at variance with specified codes, notify the Architect/Engineer immediately. Architect/Engineer shall issue all changes in accordance with the General Conditions.
- C. It shall not be the Contractor's primary responsibility to make certain that the Contract Documents are in accordance with all applicable laws, rules and regulations, however, when the Contractor performs work knowing or having reason to know that the work in question is contrary to applicable laws, rules, and regulations, and fails to notify the Architect/Engineer, the Contractor shall pay all costs arising therefrom.

1.04 DEFINITIONS

- A. Definitions:
 - 1. Codes: Codes are statutory requirements, rules or regulations of governmental entities.
 - 2. Standards: Standards are requirements that have been established as accepted criteria, set general consent.

1.05 QUALITY ASSURANCE

- A. The Architect/Engineer has designed the project to applicable code requirements and has copies of said codes available for the Contractor's inspection.
- B. The Contractor shall:
 - 1. Ensure that copies of codes and standards referenced herein or specified in individual specifications sections are available to Contractor's personnel, agents, and Sub-Contractors.
 - 2. Ensure that Contractor's personnel, agents, and Sub-Contractors are familiar with the workmanship and requirements of applicable codes and standards.

1.06 REGULATORY REQUIREMENTS

- A. Source and Requirements: Verify amendments with local code officials.
 - 1. Illinois Community College Board code requirements:

- a. ICC International Building Code, 2015 Edition.
- b. ICC International Mechanical Code, 2015 Edition.
- c. National Electrical Code, 2014 Edition.
- d. NFPA No. 101 Life Safety Code, 2000 Edition.
- 2. State code requirements:
 - a. Capital Development Board (CDB):
 - 1) Illinois Accessibility Code, 1997 Edition.
 - 2) Illinois Energy Conservation Code (ICC International Energy Conservation Code, 2012 Edition, with State of Illinois modifications).
 - b. Illinois Department of Public Health (IDPH):
 - 1) Illinois Plumbing Code (Illinois Administrative Code, Title 77, Chapter I, Subchapter r, Part 890).
 - c. Illinois Environmental Protection Agency (IEPA):
 - 1) Air-Pollution Standards.
 - 2) Noise Pollution Standards.
 - 3) Water Pollution Standards.
 - 4) Public Water Supplies
 - 5) Solid Waste Standards.
 - d. Illinois State Fire Marshal (OSFM):
 - 1) Boiler & Pressure Vessel Safety Code (Illinois Administrative Code, Title 44, Chapter I, Part 120).
 - 2) Illinois Rules & Regulations for Fire Prevention & Safety (Illinois Administrative Code 100).
- 3. Information and Requirements for Utility Services: Local utility companies.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

SECTION 01 42 00 REFERENCES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Drawing symbols, abbreviations and acronyms.
- B. Definitions of terms used throughout the Contract Documents.
- C. Explanation of specification format and content.
- D. Requirements relating to referenced standards.
- E. Applicability of referenced standards.
- F. List of industry organizations and certain of their respective documents.

1.02 DRAWING SYMBOLS AND CONVENTIONS

- A. Abbreviations and graphic symbols are defined on the General Notes, Symbols & Abbreviations sheet of the drawings.
- B. Generally, symbols used on the mechanical and electrical drawings conform to those recommended by ASHRAE, though, where appropriate, these symbols are supplemented by more specific symbols as recommended by ASME, ASPE, or the IEEE.

1.03 DEFINITIONS

- A. Where the terms "indicated", "noted", "scheduled", "shown", or "specified" are used it is to help locate the reference; no limitation on location is intended except as specifically noted.
- B. Where the terms "directed", "requested", "authorized", "approved", are used as in "directed by the Architect/Engineer", no implied meaning shall be construed to extend the Architect/Engineer's responsibilities into the Contractor's purview of construction supervision.
- C. Where the term "approved" is used in conjunction with the Architect/Engineer's action on submittals, requests or applications it is limited to the duties of the Architect/Engineer as described in the Agreement, and the General and Supplemental Conditions of the Contract. Such use of the term "approval" shall not limit or release the Contractor from his responsibility to fulfill Contract requirements.
- D. Where the term "regulations" is used it means all applicable statutes, laws, ordinances, and orders issued by authorities having jurisdiction, as well as construction industry standards, rules, or conventions that address performance of the Work.
- E. Where the term "furnish" is used it means supply, deliver, and unload to the construction site ready for assembly and incorporation into the Work.
- F. Where the term "install" is used it is meant to describe operations at the job site to include unloading, assembling, placing, anchoring, finishing, protecting, cleaning and all other similar operations required to fully incorporate an item into the Work.
- G. Where the term "provide" is used it means "furnish and install" as defined above.

H. The "Project Site" is the space available to the Contractor for performance of construction activities. The Project Site may be for the exclusive use of the Contractor and his activities or may be used in conjunction with others with others performing other construction or related activities on the Project. The Extent of the Project Site is indicated on the Drawings.

1.04 SPECIFICATION FORMAT AND CONTENT

- A. These Specifications are based on the Construction Specification Institute's 49 Division format and numbering system.
- B. Language used in the Specifications and other Contract Documents is an abbreviated type. Implied words and meanings will appropriately interpreted.
- C. Requirements expressed in imperative and streamlined language are to be performed by the Contractor. At certain locations in the text, subjective language may be used to describe responsibilities that must be fulfilled indirectly by the Contractor or others.
 - 1. Whenever a colon (:) is used within a sentence or phrase, it shall be construed to mean the words "shall be".
- D. Use of certain terms such as "carpentry" is not intended to imply that certain activities must be performed by accredited or unionized individuals of a corresponding generic name. The Specifications do, however, require that certain construction activities shall be performed by specialists who are recognized experts in the operations to be performed. Specialists shall be used for said activities, however the final responsibility for fulfilling the requirements of the Contract remains the Contractor's.

1.05 QUALITY ASSURANCE

- A. For products or workmanship specified by reference to a document or documents not included in the Project Manual, also referred to as reference standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Conform to reference standard of date of issue specified in this section, except where a specific date is established by applicable code.
- C. Obtain copies of standards when required by the Contract Documents.
- D. Maintain copy at project site during submittals, planning, and progress of the specific work, until Substantial Completion.
- E. Should specified reference standards conflict with Contract Documents, request clarification from the Architect/Engineer before proceeding.
- F. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of the Architect/Engineer shall be altered by the Contract Documents by mention or inference otherwise in any reference document.

1.06 APPLICABILITY OF INDUSTRY STANDARDS

A. Construction industry standards shall have the same force and effect as if bound or copied directly in the Contract Documents, except where more stringent requirements are specified. All such applicable standards are made a part of the Contract Documents by reference.

- 1. Where compliance with two or more standards are referenced and conflicting requirements for quality or quantities occur, comply with the more stringent requirements. Refer questions regarding apparently conflicting standards to the Architect for a decision before proceeding.
- 2. The standard of quality or quantity levels specified, shown, or referenced shall be the minimum to be provided or performed. Refer questions regarding standards of minimum quality or quantity to the Architect before proceeding.

1.07 CONSTRUCTION INDUSTRY ORGANIZATIONS AND DOCUMENTS

- A. AA -- ALUMINUM ASSOCIATION, INC.
- B. AABC -- ASSOCIATED AIR BALANCE COUNCIL
- C. AASHTO -- AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
- D. ACI -- AMERICAN CONCRETE INSTITUTE INTERNATIONAL
- E. AISC -- AMERICAN INSTITUTE OF STEEL CONSTRUCTION, INC.
- F. ANSI -- AMERICAN NATIONAL STANDARDS INSTITUTE
- G. ASHRAE -- AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC.
- H. ASME -- THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
- I. ASTM -- AMERICAN SOCIETY FOR TESTING AND MATERIALS
- J. AWS -- AMERICAN WELDING SOCIETY
- K. BHMA -- BUILDERS HARDWARE MANUFACTURERS ASSOCIATION
- L. CPSC -- CONSUMER PRODUCTS SAFETY COMMISSION
- M. DHI -- DOOR AND HARDWARE INSTITUTE
- N. FM -- FACTORY MUTUAL RESEARCH CORPORATION
- O. ICC -- INTERNATIONAL CODE COUNCIL, INC.
- P. IEEE -- INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS
- Q. ISO -- INTERNATIONAL STANDARDS ORGANIZATION
- R. NAAMM -- THE NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS
- S. NCMA -- NATIONAL CONCRETE MASONRY ASSOCIATION
- T. NEBB -- NATIONAL ENVIRONMENTAL BALANCING BUREAU
- U. NEMA -- NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
- V. NFPA -- NATIONAL FIRE PROTECTION ASSOCIATION
- W. NRCA -- NATIONAL ROOFING CONTRACTORS ASSOCIATION

- X. SMACNA -- SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION, INC.
- Y. SSPC -- THE SOCIETY FOR PROTECTIVE COATINGS
- Z. UL -- UNDERWRITERS LABORATORIES INC.
- AA. USG -- UNITED STATES GYPSUM
 - 1. USG (HB) Gypsum Construction Handbook; Seventh Edition.

1.08 UNITED STATES GOVERNMENT AND RELATED AGENCIES/DOCUMENTS

- A. CFR -- CODE OF FEDERAL REGULATIONS
- B. CPSC -- CONSUMER PRODUCTS SAFETY COMMISSION
- C. EPA -- ENVIRONMENTAL PROTECTION AGENCY
- D. FS -- FEDERAL SPECIFICATIONS AND STANDARDS (General Services Administration)
- E. GSA -- U.S. GENERAL SERVICES ADMINISTRATION
- F. USGS -- UNITED STATES GEOLOGICAL SURVEY

1.09 STATE GOVERNMENT AND RELATED AGENCIES/DOCUMENTS

- A. CDB -- ILLINOIS CAPITAL DEVELOPMENT BOARD
- B. IDOL -- ILLINOIS DEPARTMENT OF LABOR
- C. IDPH -- ILLINOIS DEPARTMENT OF PUBLIC HEALTH
- D. IEPA -- ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
- E. OSFM -- OFFICE OF THE ILLINOIS STATE FIRE MARSHAL.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

SECTION 01 60 00 PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General product requirements.
- B. Transportation, handling, storage and protection.
- C. Product option requirements.
- D. Procedures for Owner-supplied products.
- E. Maintenance materials, including extra materials, spare parts, tools, and software.

1.02 SUBMITTALS

- A. Product Data Submittals: Submit manufacturer's standard published data. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
- B. Shop Drawing Submittals: Prepared specifically for this Project; indicate utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

PART 2 PRODUCTS

2.01 NEW PRODUCTS

- A. Provide new products unless specifically required or permitted by the Contract Documents.
- B. Designed, manufactured, and tested in accordance with industry standards.

2.02 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.
- B. Products Specified by Naming One or More Manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.
- C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

2.03 MAINTENANCE MATERIALS

- A. Furnish extra materials, spare parts, tools, and software of types and in quantities specified in individual specification sections.
- B. Deliver to Project site and place in location directed by Owner's representative; obtain Owner's signature on receipt for delivery prior to final payment. Submit signed receipts with Closeout Submittals.

PART 3 EXECUTION

3.01 OWNER-SUPPLIED PRODUCTS

- A. Owner's Responsibilities:
 - 1. Arrange for and deliver Owner reviewed shop drawings, product data, and samples, to Contractor.
 - 2. Arrange and pay for product delivery to site.
 - 3. On delivery, inspect products jointly with Contractor.
 - 4. Submit claims for transportation damage and replace damaged, defective, or deficient items.
 - 5. Arrange for manufacturers' warranties, inspections, and service.
- B. Contractor's Responsibilities:
 - 1. Review Owner reviewed shop drawings, product data, and samples.
 - 2. Receive and unload products at site; inspect for completeness or damage jointly with Owner.
 - 3. Handle, store, install and finish products.
 - 4. Repair or replace items damaged after receipt.
 - 5. Make final connections to Owner-provided equipment, and test equipment.

3.02 TRANSPORTATION AND HANDLING

- A. Package products for shipment in manner to prevent damage; for equipment, package to avoid loss of factory calibration.
- B. If special precautions are required, attach instructions prominently and legibly on outside of packaging.
- C. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.
- D. Transport and handle products in accordance with manufacturer's instructions.
- E. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.
- F. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.
- G. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage, and to minimize handling.
- H. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.03 STORAGE AND PROTECTION

- A. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication.
- B. Store and protect products in accordance with manufacturers' instructions.
- C. Store with seals and labels intact and legible.

- D. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.
- E. For exterior storage of fabricated products, place on sloped supports above ground.
- F. Protect products from damage or deterioration due to construction operations, weather, precipitation, humidity, temperature, sunlight and ultraviolet light, dirt, dust, and other contaminants.
- G. Comply with manufacturer's warranty conditions, if any.
- H. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- I. Prevent contact with material that may cause corrosion, discoloration, or staining.
- J. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- K. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

SECTION 01 70 00 EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Examination, preparation, and general installation procedures.
- B. Requirements for alterations work, including selective demolition, except removal, disposal, and/or remediation of hazardous materials and toxic substances.
- C. Cutting and patching.
- D. Cleaning and protection.
- E. Starting of systems and equipment.
- F. Demonstration and instruction of Owner personnel.
- G. Closeout procedures, including Contractor's Correction Punch List, except payment procedures.

1.02 RELATED REQUIREMENTS

- A. Section 01 30 00 Administrative Requirements: Submittals procedures, Electronic document submittal service.
- B. Section 01 78 00 Closeout Submittals: Project record documents, operation and maintenance data, warranties .
- C. Section 01 79 00 Demonstration and Training: Demonstration of products and systems to be commissioned and where indicated in specific specification sections

1.03 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Cutting and Patching: Submit written request in advance of cutting or alteration that affects:
 - 1. Structural integrity of any element of Project.
 - 2. Integrity of weather exposed or moisture resistant element.
 - 3. Efficiency, maintenance, or safety of any operational element.
 - 4. Visual qualities of sight exposed elements.
 - 5. Work of Owner or separate Contractor.

1.04 PROJECT CONDITIONS

- A. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.
- B. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion.
- C. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

- D. Dust Control: Execute work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into atmosphere and over adjacent property.
 - 1. Provide dust-proof barriers between construction areas and areas continuing to be occupied by Owner.
- E. Noise Control: Provide methods, means, and facilities to minimize noise produced by construction operations.
- F. Pest and Rodent Control: Provide methods, means, and facilities to prevent pests and insects from damaging the work.
- G. Rodent Control: Provide methods, means, and facilities to prevent rodents from accessing or invading premises.
- H. Pollution Control: Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations. Comply with federal, state, and local regulations.

1.05 COORDINATION

- A. Coordinate scheduling, submittals, and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- B. Notify affected utility companies and comply with their requirements.
- C. Verify that utility requirements and characteristics of new operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- D. Coordinate space requirements, supports, and installation of mechanical and electrical work that are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- E. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
- F. Coordinate completion and clean-up of work of separate sections.
- G. After Owner occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

PART 2 PRODUCTS

2.01 PATCHING MATERIALS

- A. New Materials: As specified in product sections; match existing products and work for patching and extending work.
- B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.
- B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.
- C. Examine and verify specific conditions described in individual specification sections.
- D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.
- E. Verify that utility services are available, of the correct characteristics, and in the correct locations.
- F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

3.02 PREPARATION

- A. Clean substrate surfaces prior to applying next material or substance.
- B. Seal cracks or openings of substrate prior to applying next material or substance.
- C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.
- B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.
- C. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.
- D. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.
- E. Make neat transitions between different surfaces, maintaining texture and appearance.

3.04 ALTERATIONS

- A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
 - 1. Verify that construction and utility arrangements are as indicated.
 - 2. Report discrepancies to Architect/Engineer before disturbing existing installation.
 - 3. Beginning of alterations work constitutes acceptance of existing conditions.
- B. Keep areas in which alterations are being conducted separated from other areas that are still occupied.

- C. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage.
 - 1. Where openings in exterior enclosure exist, provide construction to make exterior enclosure weatherproof.
 - 2. Insulate existing ducts or pipes that are exposed to outdoor ambient temperatures by alterations work.
- D. Remove existing work as indicated and as required to accomplish new work.
 - 1. Remove items indicated on Drawings.
 - 2. Relocate items indicated on Drawings.
 - 3. Where new surface finishes are to be applied to existing work, perform removals, patch, and prepare existing surfaces as required to receive new finish; remove existing finish if necessary for successful application of new finish.
 - 4. Where new surface finishes are not specified or indicated, patch holes and damaged surfaces to match adjacent finished surfaces as closely as possible.
- E. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove, relocate, and extend existing systems to accommodate new construction.
 - 1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components; if necessary, modify installation to allow access or provide access panel.
 - 2. Where existing systems or equipment are not active and Contract Documents require reactivation, put back into operational condition; repair supply, distribution, and equipment as required.
 - 3. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 - a. Disable existing systems only to make switchovers and connections; minimize duration of outages.
 - b. Provide temporary connections as required to maintain existing systems in service.
 - 4. Verify that abandoned services serve only abandoned facilities.
 - 5. Remove abandoned pipe, ducts, conduits, and equipment; remove back to source of supply where possible, otherwise cap stub and tag with identification; patch holes left by removal using materials specified for new construction.
- F. Protect existing work to remain.
 - 1. Prevent movement of structure; provide shoring and bracing if necessary.
 - 2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
 - 3. Repair adjacent construction and finishes damaged during removal work.
- G. Adapt existing work to fit new work: Make as neat and smooth transition as possible.
- H. Patching: Where the existing surface is not indicated to be refinished, patch to match the surface finish that existed prior to cutting. Where the surface is indicated to be refinished, patch so that the substrate is ready for the new finish.
- I. Refinish existing surfaces as indicated:

- 1. Where rooms or spaces are indicated to be refinished, refinish all visible existing surfaces to remain to the specified condition for each material, with a neat transition to adjacent finishes.
- 2. If mechanical or electrical work is exposed accidentally during the work, re-cover and refinish to match.
- J. Remove demolition debris and abandoned items from alterations areas and dispose of off-site; do not burn or bury.
- K. Do not begin new construction in alterations areas before demolition is complete.
- L. Comply with all other applicable requirements of this section.

3.05 CUTTING AND PATCHING

- A. Whenever possible, execute the work by methods that avoid cutting or patching.
- B. See Alterations article above for additional requirements.
- C. Perform whatever cutting and patching is necessary to:
 - 1. Complete the work.
 - 2. Fit products together to integrate with other work.
 - 3. Provide openings for penetration of mechanical, electrical, and other services.
 - 4. Match work that has been cut to adjacent work.
 - 5. Repair areas adjacent to cuts to required condition.
 - 6. Repair new work damaged by subsequent work.
 - 7. Remove samples of installed work for testing when requested.
 - 8. Remove and replace defective and non-conforming work.
- D. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.
- E. Employ original installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.
- F. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.
- G. Restore work with new products in accordance with requirements of Contract Documents.
- H. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- I. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material, to full thickness of the penetrated element.
- J. Patching:
 - 1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
 - 2. Match color, texture, and appearance.
 - 3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

3.06 PROTECTION OF INSTALLED WORK

- A. Protect installed work from damage by construction operations.
- B. Provide special protection where specified in individual specification sections.
- C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- F. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- G. Remove protective coverings when no longer needed; reuse or recycle coverings if possible.

3.07 SYSTEM STARTUP

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions that may cause damage.
- C. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
- D. Verify that wiring and support components for equipment are complete and tested.
- E. Execute start-up under supervision of applicable Contractor personnel and manufacturer's representative in accordance with manufacturers' instructions.
- F. Submit a written report that equipment or system has been properly installed and is functioning correctly.

3.08 DEMONSTRATION AND INSTRUCTION

A. See Section 01 79 00 - Demonstration and Training.

3.09 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

3.10 CLOSEOUT PROCEDURES

- A. See Section 01 77 00 for additional requirements.
- B. Make submittals that are required by governing or other authorities.
- C. Accompany Project Coordinator on preliminary inspection to determine items to be listed for completion or correction in the Contractor's Correction Punch List for Contractor's Notice of Substantial Completion.

- D. Notify Architect/Engineer when work is considered ready for Architect/Engineer's Substantial Completion inspection.
- E. Submit written certification containing Contractor's Correction Punch List, that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for Architect/Engineer's Substantial Completion inspection.
- F. Conduct Substantial Completion inspection and create Final Correction Punch List containing Architect/Engineer's and Contractor's comprehensive list of items identified to be completed or corrected and submit to Architect/Engineer.
- G. Correct items of work listed in Final Correction Punch List and comply with requirements for access to Owner-occupied areas.
- H. Notify Architect/Engineer when work is considered finally complete and ready for Architect/Engineer's Substantial Completion final inspection.
- I. Complete items of work determined by Architect/Engineer listed in executed Certificate of Substantial Completion.

SECTION 01 77 00 CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES:

- A. Substantial Completion Procedures.
- B. Final Completion Procedures.

1.02 RELATED REQUIREMENTS:

A. Section 01 78 00 - Closeout Submittals.

1.03 SUBSTANTIAL COMPLETION PROCEDURES

- A. Pre-Substantial Completion Conference:
 - 1. General Contractor to schedule a Pre-substantial Completion Conference 15 days prior to the date of Substantial Completion, prepare an agenda with copies for the participants and preside over the meeting.
 - 2. Attendance Required: Contractor, Architect/Engineer and Owner.
 - 3. Minimum Agenda:
 - a. Schedule dates of Substantial Completion and Owner occupancy.
 - b. Schedule dates for Initial Punch Lists of respective Subcontractors to be produced.
 - c. Schedule date for written request for Substantial Completion.
 - d. Schedule target date for completion of Initial Punch List items.
 - e. Schedule delivery times for Owner-furnished items to be installed by Contractor, Owner's own forces or others under separate Contracts.
 - f. Schedule dates for Demonstration and Training of equipment and systems specified.
 - g. Schedule completion dates of testing and balancing reports for engineered Systems.
 - h. Scheduling and Sequencing of Construction operations around areas partially occupied.
 - i. Review job site security during transition of Owner occupancy.
 - j. Schedule dates for final inspections from authorities having jurisdiction for Occupancy Permits.
 - k. Review protocol for claims from potential move-in damage.
 - I. Review procedures for final cleaning.
 - m. Review potential concerns regarding environmental conditions.
 - 4. Record minutes and distribute copies within three days after meeting to participants and those affected by decisions made.
- B. Substantial Completion Procedures:
 - 1. When the Work or a portion of the Work is considered to be substantially complete, the Contractor inspects the project and prepares a comprehensive list of outstanding items to be completed or corrected, Initial Punch List.
 - 2. Contractor submits notice of Substantial Completion.
 - 3. Contractor completes items on the Initial Punch List.
 - 4. Architect/Engineer inspects the project to verify substantial completion and prepares a Final Punch List.

5. Architect/Engineer prepares Certificate of Substantial Completion, acceptance is required by Owner and Contractor.

1.04 FINAL COMPLETION PROCEDURES

- A. Final Completion Procedures:
 - 1. When items on Initial and Final Punch Lists are complete, the Contractor submits notice of final completion and final application for payment.
 - 2. Contractor submits Final Closeout Submittals as specified in Section 01 78 00.
 - 3. Architect inspects project and verifies the Work is acceptable and conforms with the Contract Documents.
 - 4. Architect processes final application for payment and closeout submittals.

1.05 CORRECTION PERIOD

- A. Correction Period commences on the date of Substantial Completion and expires one year from that date.
- B. Owner: document non-conforming or defective work over course of Correction Period. Notify Contractor in writing of nonconforming or defective work. Copy Architect/Engineer.
 - 1. Life safety issues requiring immediate corrective work: Contact Contractor for action.

C. Post Construction Walk Through:

- 1. Time: eleven months after the date of Substantial Completion convene a meeting on site.
- 2. Attendees: Architect/Engineer, Owner's Representative, End User and Maintenance Staff.
- 3. Minimum Agenda:
 - a. Review Owner's list of non-conforming or defective work.
 - b. Conduct a walk through of the building and grounds
 - c. Prepare a list of additional non-conforming or defective work items.
- 4. Architect/Engineer:
 - a. Prepare written report of findings within two weeks of meeting.
 - b. Notify Contractor of impending corrective work requiring action.
 - c. Monitor execution of corrective Work.

PART 2 PRODUCTS - NOT USED.

PART 3 EXECUTION - NOT USED.

SECTION 01 78 00 CLOSEOUT SUBMITTALS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Project Record Documents.
- B. Operation and Maintenance Data.
- C. Warranties and bonds.

1.02 RELATED REQUIREMENTS

- A. Section 01 30 00 Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.
- B. Section 01 70 00 Execution and Closeout Requirements: Contract closeout procedures.
- C. Individual Product Sections: Specific requirements for operation and maintenance data.
- D. Individual Product Sections: Warranties required for specific products or Work.

1.03 SUBMITTALS

- A. Project Record Documents: Submit documents to Architect/Engineer with claim for final Application for Payment.
- B. Operation and Maintenance Data:
 - 1. Submit preliminary draft or proposed formats and outlines of contents before start of Work. Architect/Engineer will review draft and return with comments.
 - 2. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit completed documents within ten days after acceptance.
 - 3. Submit completed documents 15 days prior to final inspection. This copy will be reviewed and returned after final inspection, with Architect/Engineer comments. Revise content as required prior to final submission.
 - 4. Submit revised final documents in final in PDF file format on USB flash drive form within 10 days after final inspection.
- C. Warranties and Bonds:
 - 1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within 10 days after acceptance.
 - 2. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
 - 3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PROJECT RECORD DOCUMENTS

- A. Maintain on site one set of the following record documents; record actual revisions to the Work:
 - 1. Drawings.
 - 2. Specifications.
 - 3. Addenda.
 - 4. Change Orders and other modifications to the Contract.
 - 5. Reviewed shop drawings, product data, and samples.
 - 6. Manufacturer's instruction for assembly, installation, and adjusting.
- B. Ensure entries are complete and accurate, enabling future reference by Owner.
- C. Store record documents separate from documents used for construction.
- D. Record information concurrent with construction progress.
- E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
 - 1. Manufacturer's name and product model and number.
 - 2. Product substitutions or alternates utilized.
 - 3. Changes made by Addenda and modifications.
- F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
 - 1. Measured depths of foundations in relation to finish first floor datum.
 - 2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - 3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
 - 4. Field changes of dimension and detail.
 - 5. Details not on original Contract drawings.

3.02 OPERATION AND MAINTENANCE DATA

- A. Source Data: For each product or system, list names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.
- B. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.
- C. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.
- D. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

3.03 OPERATION AND MAINTENANCE DATA FOR MATERIALS AND FINISHES

- A. For Each Product, Applied Material, and Finish:
 - 1. Product data, with catalog number, size, composition, and color and texture designations.
 - 2. Information for re-ordering custom manufactured products.
- B. Instructions for Care and Maintenance: Manufacturer's recommendations for cleaning agents and methods, precautions against detrimental cleaning agents and methods, and recommended schedule for cleaning and maintenance.
- C. Moisture protection and weather-exposed products: Include product data listing applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.
- D. Additional information as specified in individual product specification sections.
- E. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

3.04 OPERATION AND MAINTENANCE DATA FOR EQUIPMENT AND SYSTEMS

- A. For Each Item of Equipment and Each System:
 - 1. Description of unit or system, and component parts.
 - 2. Identify function, normal operating characteristics, and limiting conditions.
 - 3. Include performance curves, with engineering data and tests.
 - 4. Complete nomenclature and model number of replaceable parts.
- B. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.
- C. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; typed.
- D. Include color coded wiring diagrams as installed.
- E. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.
- F. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- G. Provide servicing and lubrication schedule, and list of lubricants required.
- H. Include manufacturer's printed operation and maintenance instructions.
- I. Include sequence of operation by controls manufacturer.
- J. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

- K. Provide control diagrams by controls manufacturer as installed.
- L. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- M. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- N. Include test and balancing reports.
- O. Additional Requirements: As specified in individual product specification sections.

3.05 ASSEMBLY OF OPERATION AND MAINTENANCE MANUALS

- A. Assemble operation and maintenance data into PDF file "manual" for Owner's personnel use, with data arranged in the same sequence as, and bookmarked by, the specification sections.
 - 1. Media: USB flash drive of capacity sufficient to store entire PDF file, fragmented.
 - 2. Attach a tag or label flash drive with Project name, date, and the title "O&M Manual".
- B. Where systems involve more than one specification section, provide separate bookmark for each system.
- C. Prepare instructions and data by personnel experienced in maintenance and operation of described products.
- D. Prepare data in the form of an instructional manual.
- E. Cover Page: Populate the first page of the PDF file with: printed title "OPERATION AND MAINTENANCE MANUAL; identify title of Project; identify subject matter of contents.
- F. Project Directory: Beginning on the second page of the PDF file; provide Title and address of Project; names, addresses, and telephone numbers of Architect/Engineer, Consultants,Contractorand subcontractors, with names of responsible parties.
- G. Table of Contents: List every item identified by a bookmark, using the same identification as in the title of the bookmark.
- H. Bookmarks: Bookmark each separate product and system; identify the contents in the title of the bookmark; on the bookmarked page provide a description of product and major component parts of equipment.
- I. Content: Manufacturer's printed data, legibly scanned, in color where applicable, at 300 dpi resolution.
- J. Drawings: Legibly scanned, in color where applicable, at 300 dpi resolution; PDF file page size to match native sheet size of original drawing.
- K. Arrangement of Contents: Organize each volume in parts as follows:
 - 1. Project Directory.
 - 2. Table of Contents, of all volumes, and of this volume.
 - 3. Operation and Maintenance Data: Arranged by system, then by product category.
 - a. Source data.
 - b. Product data, shop drawings, and other submittals.

- c. Operation and maintenance data.
- d. Field quality control data.
- e. Warranties and bonds.

3.06 WARRANTIES AND BONDS

- A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial completion is determined.
- B. Verify that documents are in proper form, contain full information, and are notarized.
- C. Co-execute submittals when required.
- D. Retain warranties and bonds until time specified for submittal.
- E. Include color, 300 dpi resolution scans of each in Operation and Maintenance Manual PDF file, bookmarked indexed separately in Table of Contents.
- F. Manual: Bind original copies of warranties and bonds in commercial quality 8-1/2 by 11 inch three D side ring binders with durable plastic covers.
- G. Cover: Identify each binder with typed or printed title WARRANTIES AND BONDS, with title of Project; name, address and telephone number of Contractor and equipment supplier; and name of responsible company principal.
- H. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the specification section in which specified, and the name of product or work item.
- I. Separate each warranty or bond with index tab sheets keyed to the Table of Contents listing. Provide full information, using separate typed sheets as necessary. List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal. END OF SECTION

SECTION 01 79 00 DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.01 SUMMARY

- A. Demonstration of products and systems where indicated in specific specification sections.
- B. Training of Owner personnel in operation and maintenance is required for:
 - 1. All software-operated systems.
 - 2. HVAC systems and equipment.
 - 3. Plumbing equipment.
 - 4. Electrical systems and equipment.

1.02 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Training Plan: Owner will designate personnel to be trained; tailor training to needs and skill-level of attendees.
 - 1. Submit to Architect/Engineer for transmittal to Owner.
 - 2. Submit not less than four weeks prior to start of training.
 - 3. Revise and resubmit until acceptable.
 - 4. Provide an overall schedule showing all training sessions.
 - 5. Include at least the following for each training session:
 - a. Identification, date, time, and duration.
 - b. Description of products and/or systems to be covered.
 - c. Name of firm and person conducting training; include qualifications.
 - d. Intended audience, such as job description.
 - e. Objectives of training and suggested methods of ensuring adequate training.
 - f. Methods to be used, such as classroom lecture, live demonstrations, hands-on, etc.
 - g. Media to be used, such a slides, hand-outs, etc.
 - h. Training equipment required, such as projector, projection screen, etc., to be provided by Contractor.
- C. Training Manuals: Provide training manual for each attendee; allow for minimum of two attendees per training session.
 - 1. Include applicable portion of O&M manuals.
 - 2. Include copies of all hand-outs, slides, overheads, video presentations, etc., that are not included in O&M manuals.
 - 3. Provide one extra copy of each training manual to be included with operation and maintenance data.
- D. Training Reports:
 - 1. Identification of each training session, date, time, and duration.
 - 2. Sign-in sheet showing names and job titles of attendees.
 - 3. List of attendee questions and written answers given, including copies of and references to supporting documentation required for clarification; include answers to questions that could not be answered in original training session.

- E. Video Recordings: Submit digital video recording of each demonstration and training session for Owner's subsequent use.
 - 1. Format: DVD Disc.
 - 2. Label each disc and container with session identification and date.

1.03 QUALITY ASSURANCE

- A. Instructor Qualifications: Familiar with design, operation, maintenance and troubleshooting of the relevant products and systems.
 - 1. Provide as instructors the most qualified trainer of those contractors and/or installers who actually supplied and installed the systems and equipment.
 - 2. Where a single person is not familiar with all aspects, provide specialists with necessary qualifications.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 DEMONSTRATION - GENERAL

- A. Demonstrations conducted during system start-up do not qualify as demonstrations for the purposes of this section, unless approved in advance by Owner.
- B. Demonstration may be combined with Owner personnel training if applicable.
- C. Operating Equipment and Systems: Demonstrate operation in all modes, including start-up, shut-down, seasonal changeover, emergency conditions, and troubleshooting, and maintenance procedures, including scheduled and preventive maintenance.
 - 1. Perform demonstrations not less than two weeks prior to Substantial Completion.
 - 2. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- D. Non-Operating Products: Demonstrate cleaning, scheduled and preventive maintenance, and repair procedures.
 - 1. Perform demonstrations not less than two weeks prior to Substantial Completion.

3.02 TRAINING - GENERAL

- A. Conduct training on-site unless otherwise indicated.
- B. Owner will provide classroom and seating at no cost to Contractor.
- C. Provide training in minimum two hour segments.
- D. Training schedule will be subject to availability of Owner's personnel to be trained; re-schedule training sessions as required by Owner; once schedule has been approved by Owner failure to conduct sessions according to schedule will be cause for Owner to charge Contractor for personnel "show-up" time.
- E. Review of Facility Policy on Operation and Maintenance Data: During training discuss:1. The location of the O&M manuals and procedures for use and preservation; backup copies.

- 2. Typical contents and organization of all manuals, including explanatory information, system narratives, and product specific information.
- 3. Typical uses of the O&M manuals.
- F. Product- and System-Specific Training:
 - 1. Review the applicable O&M manuals.
 - 2. For systems, provide an overview of system operation, design parameters and constraints, and operational strategies.
 - 3. Review instructions for proper operation in all modes, including start-up, shut-down, seasonal changeover and emergency procedures, and for maintenance, including preventative maintenance.
 - 4. Provide hands-on training on all operational modes possible and preventive maintenance.
 - 5. Emphasize safe and proper operating requirements; discuss relevant health and safety issues and emergency procedures.
 - 6. Discuss common troubleshooting problems and solutions.
 - 7. Discuss any peculiarities of equipment installation or operation.
 - 8. Discuss warranties and guarantees, including procedures necessary to avoid voiding coverage.
 - 9. Review recommended tools and spare parts inventory suggestions of manufacturers.
 - 10. Review spare parts and tools required to be furnished by Contractor.
 - 11. Review spare parts suppliers and sources and procurement procedures.
- G. Be prepared to answer questions raised by training attendees; if unable to answer during training session, provide written response within three days.
SECTION 02 41 00 DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Selective demolition of built site elements.
- B. Selective demolition of building elements for alteration purposes.
- C. Abandonment and removal of existing utilities and utility structures.

1.02 RELATED REQUIREMENTS

- A. Section 01 60 00 Product Requirements: Handling and storage of items removed for salvage and relocation.
- B. Section 01 70 00 Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring.

1.03 REFERENCE STANDARDS

- A. 29 CFR 1926 U.S. Occupational Safety and Health Standards; current edition.
- B. NFPA 241 Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2013.

1.04 DEFINITIONS

- A. Where the term "demolish" is used it shall be construed to mean remove and legally dispose of off site.
- B. Where the term "refurbish" is used it shall be construed to mean refinish, repair and otherwise restore to like-new condition.
- C. Where the term "relocate" is used it shall be construed to mean disconnect from existing utilities, move to new location and reinstall and reconnect to utilities.
- D. Where the term "salvage" is used it shall be construed to mean carefully remove so as to prevent damage.
 - If the item is to be saved for reinstallation or relocation as part of the Work, "salvage" shall also be construed to mean clean, adjust, lubricate and otherwise restore to best possible condition without repair or refinishing. Otherwise, "salvage" shall mean clean item surfaces and turn over to the Owner for storage and possible future use.
- E. Where the phrase "salvage in place" is used it shall be construed to mean protect in place so as to prevent damage while adjacent elements are demolished, restore to best possible condition without repair or refinishing, and modify as necessary to properly incorporate and integrate with new Work.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

1.06 QUALITY ASSURANCE

A. Demolition Firm Qualifications: Company specializing in the type of work required.1. Minimum of 3 years of documented experience.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

3.01 SCOPE

- A. Remove paving and curbs as required to accomplish new work.
- B. Remove concrete slabs on grade as indicated on drawings.
- C. Remove other items indicated, for salvage, relocation, and recycling.
- D. Fill excavations, open pits, and holes in ground areas generated as result of removals, using specified fill; compact fill as required so that required rough grade elevations do not subside within one year after completion.

3.02 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A. Comply with other requirements specified in Section 01 70 00.
- B. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 - 1. Obtain required permits.
 - 2. Comply with applicable requirements of NFPA 241.
 - 3. Use of explosives is not permitted.
 - 4. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
 - 5. Provide, erect, and maintain temporary barriers and security devices.
 - 6. Use physical barriers to prevent access to areas that could be hazardous to workers or the public.
 - 7. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
 - 8. Do not close or obstruct roadways or sidewalks without permit.
 - Conduct operations to minimize obstruction of public and private entrances and exits; do not
 obstruct required exits at any time; protect persons using entrances and exits from removal
 operations.
- C. Do not begin removal until receipt of notification to proceed from Owner.
- D. Do not begin removal until built elements to be salvaged or relocated have been removed.
- E. Do not begin removal until vegetation to be relocated has been removed and specified measures have been taken to protect vegetation to remain.
- F. Protect existing structures and other elements that are not to be removed.

- 1. Provide bracing and shoring.
- 2. Prevent movement or settlement of adjacent structures.
- 3. Stop work immediately if adjacent structures appear to be in danger.
- G. Minimize production of dust due to demolition operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.
- H. If hazardous materials are discovered during removal operations, stop work and notify Architect/Engineer and Owner; hazardous materials include regulated asbestos containing materials, lead, PCB's, and mercury.
- I. Perform demolition in a manner that maximizes salvage and recycling of materials.
 - 1. Dismantle existing construction and separate materials.
 - 2. Set aside reusable, recyclable, and salvageable materials; store and deliver to collection point or point of reuse.
- J. Partial Removal of Paving and Curbs: Neatly saw cut at right angle to surface.

3.03 EXISTING UTILITIES

- A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.
- D. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to Owner.
- E. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to Owner.
- F. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.
- G. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

3.04 SELECTIVE DEMOLITION FOR ALTERATIONS

- A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
 - 1. Verify that construction and utility arrangements are as indicated.
 - 2. Report discrepancies to Architect/Engineer before disturbing existing installation.
 - 3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.
- B. Separate areas in which demolition is being conducted from other areas that are still occupied.
- C. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage.

- D. Remove existing work as indicated and as required to accomplish new work.
 - 1. Remove rotted wood, corroded metals, and deteriorated masonry and concrete; replace with new construction specified.
 - 2. Remove items indicated on drawings.
- E. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove existing systems and equipment as indicated.
 - 1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.
 - 2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 - 3. Verify that abandoned services serve only abandoned facilities before removal.
 - 4. Remove abandoned pipe, ducts, conduits, and equipment; remove back to source of supply where possible, otherwise cap stub and tag with identification.
- F. Protect existing work to remain.
 - 1. Prevent movement of structure; provide shoring and bracing if necessary.
 - 2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
 - 3. Repair adjacent construction and finishes damaged during removal work.
 - 4. Patch as specified for patching new work.

3.05 DEBRIS AND WASTE REMOVAL

- A. Remove debris, junk, and trash from site.
- B. Leave site in clean condition, ready for subsequent work.
- C. Clean up spillage and wind-blown debris from public and private lands. END OF SECTION

SECTION 03 10 00 CONCRETE FORMING AND ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Formwork for cast-in place concrete, with shoring, bracing and anchorage.
- B. Openings for other work.
- C. Form accessories.
- D. Form stripping.

1.02 RELATED REQUIREMENTS

- A. Section 03 20 00 Concrete Reinforcing.
- B. Section 03 30 00 Cast-in-Place Concrete.

1.03 REFERENCE STANDARDS

- A. ACI 117 Standard Specifications for Tolerances for Concrete Construction and Materials; 2010.
- B. ACI 301 Specifications for Structural Concrete; 2010 (Errata 2012).
- C. ACI 318 Building Code Requirements for Structural Concrete and Commentary; 2011.
- D. ACI 347R Guide to Formwork for Concrete; 2014.
- E. PS 1 Structural Plywood; 2009.

1.04 DESIGN REQUIREMENTS

A. Design, engineer and construct formwork, shoring and bracing to conform to design and code requirements; resultant concrete to conform to required shape, line and dimension.

1.05 QUALITY ASSURANCE

A. Perform work of this section in accordance with ACI 347, ACI 301, and ACI 318.

PART 2 PRODUCTS

2.01 FORMWORK - GENERAL

- A. Provide concrete forms, accessories, shoring, and bracing as required to accomplish cast-in-place concrete work.
- B. Design and construct to provide resultant concrete that conforms to design with respect to shape, lines, and dimensions.
- C. Chamfer outside corners of beams, joists, columns, and walls.
- D. Comply with applicable State and local codes with respect to design, fabrication, erection, and removal of formwork.
- E. Comply with relevant portions of ACI 347R, ACI 301, and ACI 318.

2.02 WOOD FORM MATERIALS

A. Form Materials: At the discretion of the Contractor.

2.03 FORMWORK ACCESSORIES

- A. Form Release Agent: Capable of releasing forms from hardened concrete without staining or discoloring concrete or forming bugholes and other surface defects, compatible with concrete and form materials, and not requiring removal for satisfactory bonding of coatings to be applied.
 - 1. Composition: Colorless mineral oil-based compound.
 - 2. Do not use materials containing diesel oil or petroleum-based compounds.
- B. Filler Strips for Chamfered Corners: Rigid plastic type; 3/4 x 3/4 inch size; maximum possible lengths.
- C. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with drawings.

3.02 ERECTION - FORMWORK

- A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301.
- B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.
- C. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.
- D. Align joints and make watertight. Keep form joints to a minimum.
- E. Obtain approval before framing openings in structural members that are not indicated on drawings.
- F. Provide fillet and chamfer strips on external corners of exposed corners.
- G. Coordinate this section with other sections of work that require attachment of components to formwork.
- H. If formwork is placed after reinforcement, resulting in insufficient concrete cover over reinforcement, request instructions from Architect/Engineer before proceeding.

3.03 APPLICATION - FORM RELEASE AGENT

- A. Apply form release agent on formwork in accordance with manufacturer's recommendations.
- B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.

C. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings that are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.

3.04 INSERTS, EMBEDDED PARTS, AND OPENINGS

- A. Provide formed openings where required for items to be embedded in passing through concrete work.
- B. Locate and set in place items that will be cast directly into concrete.
- C. Coordinate with work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other work.
- D. Install accessories in accordance with manufacturer's instructions, so they are straight, level, and plumb. Ensure items are not disturbed during concrete placement.
- E. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

3.05 FORM CLEANING

- A. Clean forms as erection proceeds, to remove foreign matter within forms.
- B. Clean formed cavities of debris prior to placing concrete.
 - 1. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.
 - 2. During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out forms, unless formwork and concrete construction proceed within heated enclosure. Use compressed air or other means to remove foreign matter.

3.06 FORMWORK TOLERANCES

A. Construct formwork to maintain tolerances required by ACI 117, unless otherwise indicated.

3.07 FIELD QUALITY CONTROL

- A. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and to verify that supports, fastenings, wedges, ties, and items are secure.
- B. Do not reuse wood formwork more than 2 times for concrete surfaces to be exposed to view. Do not patch formwork.

3.08 FORM REMOVAL

- A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.
- B. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.
- C. Store removed forms to prevent damage to form materials or to fresh concrete. Discard damaged forms.

SECTION 03 20 00 CONCRETE REINFORCING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Reinforcing steel for cast-in-place concrete.
- B. Supports and accessories for steel reinforcement.

1.02 RELATED REQUIREMENTS

- A. Section 03 10 00 Concrete Forming and Accessories.
- B. Section 03 30 00 Cast-in-Place Concrete.

1.03 REFERENCE STANDARDS

- A. ACI 301 Specifications for Structural Concrete; 2010 (Errata 2012).
- B. ACI 318 Building Code Requirements for Structural Concrete and Commentary; 2011.
- C. ACI SP-66 ACI Detailing Manual; 2004.
- D. ASTM A82/A82M Standard Specification for Steel Wire, Plain, for Concrete Reinforcement; 2007.
- E. ASTM A615/A615M Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement; 2015.
- F. WWR-500- Manual of Standard Practice; Structural Welded Wire Reinforcement; Wire Reinforcement Institute; latest edition.
- G. CRSI (DA4) Manual of Standard Practice; 2009.
- H. CRSI (P1) Placing Reinforcing Bars; 2011.

1.04 SUBMITTALS

A. Shop Drawings: Comply with requirements of ACI SP-66. Include bar schedules, shapes of bent bars, spacing of bars, and location of splices.

1.05 QUALITY ASSURANCE

A. Perform work of this section in accordance with ACI 301 and ACI 318.

PART 2 PRODUCTS

2.01 REINFORCEMENT

- A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi).
 - 1. Deformed billet-steel bars.
 - 2. Unfinished.
- B. Steel Welded Wire Reinforcement (WWR): Plain type; ASTM A1064/A1064M.
 - 1. Form: Flat Sheets.
 - 2. Mesh Size and Wire Gage: As indicated on drawings.

- C. Reinforcement Accessories:
 - 1. Tie Wire: Annealed, minimum 16 gage, 0.0508 inch.
 - 2. Chairs, Bolsters, Bar Supports, Spacers: Factory made wire bar supports sized and shaped for adequate support of reinforcement during concrete placement.

2.02 FABRICATION

- A. Fabricate concrete reinforcing in accordance with CRSI (DA4) Manual of Standard Practice.
- B. Welding of reinforcement is not permitted.

PART 3 EXECUTION

3.01 PLACEMENT

- A. Place, support and secure reinforcement against displacement. Do not deviate from required position. Reinforcing "pull-up" during placement of concrete not acceptable.
- B. Accommodate placement of formed openings.
- C. Conform to applicable code for concrete cover over reinforcement. END OF SECTION

SECTION 03 30 00 CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Floors and slabs on grade.
- B. Joint devices and accessories associated with concrete work.
- C. Miscellaneous concrete elements, including equipment pads.
- D. Concrete curing.

1.02 RELATED REQUIREMENTS

- A. Section 03 10 00 Concrete Forming and Accessories.
- B. Section 03 20 00 Concrete Reinforcing.

1.03 REFERENCE STANDARDS

- A. ACI 117 Standard Specifications for Tolerances for Concrete Construction and Materials; 2010.
- B. ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; 1991 (Reapproved 2009).
- C. ACI 301 Specifications for Structural Concrete; 2010 (Errata 2012).
- D. ACI 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000.
- E. ACI 305R Hot Weather Concreting; 2010.
- F. ACI 306R Cold Weather Concreting; 2010.
- G. ACI 308R Guide to Curing Concrete; 2001 (Reapproved 2008).
- H. ACI 318 Building Code Requirements for Structural Concrete and Commentary; 2011.
- I. ASTM C33/C33M Standard Specification for Concrete Aggregates; 2013.
- J. ASTM C94/C94M Standard Specification for Ready-Mixed Concrete; 2015.
- K. ASTM C150/C150M Standard Specification for Portland Cement; 2015.
- L. ASTM C171 Standard Specification for Sheet Materials for Curing Concrete; 2007.
- M. ASTM C260/C260M Standard Specification for Air-Entraining Admixtures for Concrete; 2010a.
- N. ASTM C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete; 2011.
- O. ASTM C494/C494M Standard Specification for Chemical Admixtures for Concrete; 2013.
- P. ASTM C618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2015.
- Q. NSF 61 Drinking Water System Components Health Effects; 2014 (Errata 2015).

R. NSF 372 - Drinking Water System Components - Lead Content; 2011.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.
 - 1. For curing compounds, provide data on method of removal in the event of incompatibility with floor covering adhesives.
 - 2. Anchoring epoxy and expansion anchors.
- B. Mix Designs: Submit 15 days prior to start of work.
 - 1. Submit for each type of concrete specified.
 - 2. Include back-up test data.
 - 3. Indicate proposed mix design complies with requirements of ACI 301, Section 4 Concrete Mixtures.
 - 4. Indicate proposed mix design complies with requirements of ACI 318, Chapter 5 Concrete Quality, Mixing and Placing.

1.05 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI 301 and ACI 318.
- B. Follow recommendations of ACI 305R when concreting during hot weather.
- C. Follow recommendations of ACI 306R when concreting during cold weather.

PART 2 PRODUCTS

2.01 FORMWORK

A. Comply with requirements of Section 03 10 00.

2.02 REINFORCEMENT

A. Comply with requirements of Section 03 20 00.

2.03 CONCRETE MATERIALS

- A. Cement: ASTM C150/C150M, Type I Normal Portland type.1. Acquire cement for entire project from same source.
- B. Fine and Coarse Aggregates: ASTM C 33.1. Acquire aggregates for entire project from same source.
- C. Fly Ash: ASTM C618, Class C.
- D. Water: Clean and not detrimental to concrete.

2.04 ADMIXTURES

- A. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.
- B. Air Entrainment Admixture: ASTM C260/C260M.

- C. High Range Water Reducing and Retarding Admixture: ASTM C494/C494M Type G.
- D. High Range Water Reducing Admixture: ASTM C494/C494M Type F.
- E. Water Reducing and Accelerating Admixture: ASTM C494/C494M Type E.
- F. Water Reducing and Retarding Admixture: ASTM C494/C494M Type D.
- G. Accelerating Admixture: ASTM C494/C494M Type C.
- H. Retarding Admixture: ASTM C494/C494M Type B.
- I. Water Reducing Admixture: ASTM C494/C494M Type A.

2.05 ACCESSORY MATERIALS

- A. Anchoring Epoxy: Refer to drawings. Acceptable manufacturer's include...
 - 1. Hilti: HIT-RE500-SD injection anchoring system.
 - 2. Simpson Strong-Tie: SET-XP injection anchoring adhesive system.
 - 3. Powers Fasteners: PE 1000+ injection adhesive anchoring system.
- B. Expansion Anchors: Refer to drawings. Acceptable manufacturer's include...
 - 1. Hilti: Kwik Bolt 3 expansion anchor.
 - 2. Simpson Strong-Tie: Strong-Bolt 2 wedge anchor.

2.06 BONDING AND JOINTING PRODUCTS

- A. Latex Bonding Agent: Non-redispersable acrylic latex, complying with ASTM C1059/C1059M, Type II.
- B. Epoxy Bonding System:1. Complying with ASTM C881/C881M and of Type required for specific application.

2.07 CURING MATERIALS

- A. Curing Compound, Naturally Dissipating: Clear, water-based, liquid membrane-forming compound; complying with ASTM C309.
- B. Water: Potable, not detrimental to concrete.

2.08 CONCRETE MIX DESIGN

- A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.
- B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
 - 1. For trial mixtures method, employ independent testing agency acceptable to Architect/Engineer for preparing and reporting proposed mix designs.
- C. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer. Submit to Architect for review and approval.
- D. Normal Weight Concrete: Type "A".
 - 1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: 4,000 pounds per square inch.

- 2. Fly Ash Content: Maximum 15 percent of cementitious materials by weight.
- 3. Water-Cement Ratio: Maximum 48 percent by weight.
- 4. Total Air Content: 2 percent, determined in accordance with ASTM C 173/C 173M.
- 5. Maximum Slump: 4 inches.
- 6. Maximum Aggregate Size: 3/4 inch.

2.09 MIXING

A. Transit Mixers: Comply with ASTM C94/C94M.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify lines, levels, and dimensions before proceeding with work of this section.

3.02 PREPARATION

- A. Verify that forms are clean and free of rust before applying release agent.
- B. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.
- C. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning and applying bonding agent in according to bonding agent manufacturer's instructions.
 - 1. Use epoxy bonding system for bonding to damp surfaces, for structural load-bearing applications, and where curing under humid conditions is required.
 - 2. Use latex bonding agent only for non-load-bearing applications.
- D. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels and secure in place using approved epoxy.

3.03 PLACING CONCRETE

- A. Place concrete in accordance with ACI 304R.
- B. Place concrete for floor slabs in accordance with ACI 302.1R.
- C. Notify Architect/Engineer not less than 24 hours prior to commencement of placement operations.
- D. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- E. Ensure reinforcement, inserts, and embedded parts will not be disturbed during concrete placement.
- F. Place concrete continuously without construction (cold) joints wherever possible; where construction joints are necessary, before next placement prepare joint surface by removing laitance and exposing the sand and sound surface mortar, by sandblasting or high-pressure water jetting.
- G. Finish floors level and flat, unless otherwise indicated, within the tolerances specified below.

3.04 CONCRETE FINISHING

- A. Repair surface defects, including tie holes, immediately after removing formwork.
- B. Exposed Form Finish: Rub down or chip off and smooth fins or other raised areas 1/4 inch or more in height. Provide finish as follows:
 - 1. Smooth Rubbed Finish: Wet concrete and rub with carborundum brick or other abrasive, not more than 24 hours after form removal.
- C. Concrete Slabs: Finish to requirements of ACI 302.1R, and as follows:
 - 1. Provide 3/4" radiused edge on exposed slab edges, unless otherwise noted.
- D. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains at 1:100 nominal.

3.05 CURING AND PROTECTION

- A. Comply with requirements of ACI 308R. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
- C. Surfaces Not in Contact with Forms:
 - 1. Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by water ponding, water-saturated sand, water-fog spray, or saturated burlap.
 - a. Spraying: Spray water over floor slab areas and maintain wet.
 - b. Saturated Burlap: Saturate burlap-polyethylene and place burlap-side down over floor slab areas, lapping ends and sides; maintain in place.
 - 2. Final Curing: Begin after initial curing but before surface is dry.
 - a. Moisture-Retaining Sheet: Lap strips not less than 3 inches and seal with waterproof tape or adhesive; secure at edges.

3.06 DEFECTIVE CONCRETE

- A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
- B. Repair or replacement of defective concrete will be determined by the Architect/Engineer. The cost of additional testing shall be borne by Contractor when defective concrete is identified.
- C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Architect/Engineer for each individual area.

3.07 PROTECTION

A. Do not permit traffic over unprotected concrete floor surface until fully cured.

3.08 SCHEDULE - CONCRETE TYPES AND FINISHES

Location	Mix Type	Concrete Finish
A. Interior slab-on-grade	А	troweled
B. Equipment pads:	А	sides: smooth form
top: non-slip		

SECTION 05 50 00 METAL FABRICATIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Shop fabricated steel items.

1.02 RELATED REQUIREMENTS

A. Section 05 53 05 - Gratings and Floor Plates

1.03 REFERENCE STANDARDS

- A. ASTM A53/A53M Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- B. ASTM A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2014.
- C. ASTM A325 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2014.
- D. ASTM A500/A500M Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2013.
- E. ASTM A653/A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- F. ASTM A1011/A1011M Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2014.
- G. ASTM F3125/F3125M Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions; 2015a.
- H. AWS A2.4 Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2012.
- I. AWS D1.1/D1.1M Structural Welding Code Steel; 2015.
- J. IAS AC172 Accreditation Criteria for Fabricator Inspection Programs for Structural Steel; International Accreditation Service, Inc; 2011.
- K. SSPC-Paint 15 Steel Joist Shop Primer/Metal Building Primer; 1999 (Ed. 2004).
- L. SSPC-Paint 20 Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); 2002 (Ed. 2004).
- M. SSPC-SP 2 Hand Tool Cleaning; 1982 (Ed. 2004).

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

- B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
 - 1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
- C. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.
 - 1. Anchoring epoxy and expansion/wedge anchors.
- D. Fabricator's Qualification Statement: Provide documentation showing steel fabricator is accredited under IAS AC172.

1.05 QUALITY ASSURANCE

A. Fabricator: Company holding the contract for the work of this Section must be a fabricator, not a broker, and must self-perform all the work of this Section.

PART 2 PRODUCTS

2.01 MATERIALS - STEEL

- A. Steel Angles, Plates, and Channels: ASTM A36/A36M.
- B. Steel W Shapes and Tees: ASTM A992/A992M.
- C. Steel Tubing: ASTM A500/A500M, Grade B cold-formed structural tubing.
- D. Plates: ASTM A283/A283M.
- E. Pipe: ASTM A53/A53M, Grade B Schedule 40, black finish.
- F. Slotted Channel Framing: ASTM A653/A653M, Grade 33.
- G. Slotted Channel Fittings: ASTM A1011/A1011M.
- H. Bolts, Nuts, and Washers: ASTM F3125/F3125M, Type 1, plain.
- I. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- J. Shop and Touch-Up Primer: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction; compatible with scheduled painted finish, coating or fireproofing specified in related Sections.

2.02 ACCESSORY MATERIALS

- A. Anchoring Epoxy: Refer to drawings. Acceptable manufacturer's include...
 - 1. Hilti: HIT-HY-150 fast curing injection system.
 - 2. Simpson Strong-Tie: SET-XP high-strength anchoring adhesive.
 - 3. Powers Fasteners: Pure110+ epoxy injection adhesive anchoring system.
- B. Expansion Anchors: Refer to drawings. Acceptable manufacturer's include...
 - 1. Hilti: Kwik Bolt 3 expansion anchor.
 - 2. Simpson Strong-Tie: Strong-Bolt 2 wedge anchor.

2.03 FABRICATION

- A. Fit and shop assemble items in largest practical sections, for delivery to site.
- B. Fabricate items with joints tightly fitted and secured.
- C. Continuously seal joined members by continuous welds.
- D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- F. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.04 FABRICATED ITEMS

- A. Ledge Angles, Shelf Angles, Channels, and Plates Not Attached to Structural Framing: For support of grating; finish as scheduled below.
- B. Slotted Channel Framing: Fabricate channels and fittings from structural steel complying with the referenced standards; factory-applied, rust-inhibiting thermoset acrylic enamel finish.

2.05 FINISHES - STEEL

- A. Prime paint all steel items unless scheduled otherwise at the end of this section.
- B. Prepare surfaces to be primed in accordance with SSPC-SP2.
- C. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- D. Prime Painting: One coat.

2.06 FABRICATION TOLERANCES

- A. Squareness: 1/8 inch maximum difference in diagonal measurements.
- B. Maximum Offset Between Faces: 1/16 inch.
- C. Maximum Misalignment of Adjacent Members: 1/16 inch.
- D. Maximum Bow: 1/8 inch in 48 inches.
- E. Maximum Deviation From Plane: 1/16 inch in 48 inches.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

A. Clean and strip primed steel items to bare metal where site welding is required.

3.03 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- C. Field weld components where required .
- D. Field weld components indicated on drawings and shop drawings.
- E. Perform field welding in accordance with AWS D1.1/D1.1M.
- F. Obtain approval prior to site cutting or making adjustments not scheduled.
- G. After erection, prime welds, abrasions, and surfaces not shop primed.

3.04 TOLERANCES

- A. Maximum Offset From True Alignment: 1/4 inch.
- B. Maximum Out-of-Position: 1/4 inch.

3.05 SCHEDULE

- A. Interior Locations (Non-Corrosive Environments)Finish
 - 1. Shelf angles and deck support anglesPrimed2. Mechanical and electrical equipment rails and supportsPrimed3. Miscellaneous angles, plates, clips and shimsPrimedEND OF SECTION

SECTION 05 53 05 GRATINGS AND FLOOR PLATES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Formed metal floor gratings.

1.02 RELATED REQUIREMENTS

A. Section 05 50 00 - Metal Fabrications.

1.03 REFERENCE STANDARDS

- A. ASTM A36/A36M Standard Specification for Carbon Structural Steel; 2014.
- B. ASTM A653/A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- C. AWS A2.4 Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2012.
- D. AWS D1.1/D1.1M Structural Welding Code Steel; 2015.
- E. NAAMM MBG 531 Metal Bar Grating Manual; 2009.
- F. NAAMM MBG 532 Heavy Duty Metal Bar Grating Manual; 2009.
- G. SSPC-Paint 15 Steel Joist Shop Primer/Metal Building Primer; 1999 (Ed. 2004).
- H. SSPC-Paint 20 Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); 2002 (Ed. 2004).
- I. SSPC-SP 2 Hand Tool Cleaning; 1982 (Ed. 2004).

1.04 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide span and deflection tables.
- C. Shop Drawings: Indicate details of component supports, openings, perimeter construction details, and tolerances.
 - 1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cross Bars: ASTM B211 (ASTM B211M) solid bars.
- B. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- C. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction; compatible with scheduled painted finish or coating specified in related Sections.

2.02 ACCESSORIES

A. Fasteners and Saddle Clips: manufacturer's standard:

2.03 FABRICATION

- A. Bolt joints of intersecting metal sections.
- B. Fabricate support framing for openings.
- C. Top Surface: smooth.

2.04 FINISHES

- A. Prepare surfaces to be primed in accordance with SSPC-SP 2.
- B. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- C. Do not prime surfaces in direct contact with concrete or where field welding is required.
- D. Prime paint items with one coat.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as provided by the contractor based on measurements taken in the field.
- B. Verify that opening sizes and dimensional tolerances are acceptable.
- C. Verify that supports are correctly positioned.

3.02 INSTALLATION

- A. Install components in accordance with manufacturer's instructions.
- B. Place frames in correct position, plumb and level.
- C. Mechanically cut all finish surfaces. Do not flame cut.
- D. Anchor by bolting through saddle clips.
- E. Set perimeter closure flush with top of grating and surrounding construction.
- F. Secure to prevent movement.

3.03 TOLERANCES

A. Conform to NAAMM MBG 531.

SECTION 21 05 00 COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe, fittings, sleeves, escutcheons, seals, and connections for sprinkler systems.

1.02 REFERENCE STANDARDS

- A. ASME A112.18.1 Plumbing Supply Fittings; 2012.
- B. ASME BPVC-IX Boiler and Pressure Vessel Code, Section IX Welding, Brazing, and Fusing Qualifications; 2015.
- C. ASME B16.1 Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2010.
- D. ASME B16.3 Malleable Iron Threaded Fittings: Classes 150 and 300; 2011.
- E. ASME B16.4 Gray Iron Threaded Fittings: Classes 125 and 250; 2011.
- F. ASME B16.9 Factory-Made Wrought Buttwelding Fittings; 2012.
- G. ASME B16.25 Buttwelding Ends; 2012.
- H. ASTM A47/A47M Standard Specification for Ferritic Malleable Iron Castings; 1999 (Reapproved 2014).
- I. ASTM A536 Standard Specification for Ductile Iron Castings; 1984 (Reapproved 2014).
- J. AWWA C606 Grooved and Shouldered Joints; 2011.
- K. NFPA 13 Standard for the Installation of Sprinkler Systems; 2016.
- L. UL (DIR) Online Certifications Directory; current listings at database.ul.com.

1.03 SUBMITTALS

- A. Product Data: Provide manufacturers catalogue information. Indicate valve data and ratings.
- B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
- C. Project Record Documents: Record actual locations of components and tag numbering.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Conform to UL and FM requirements.
- C. Valves: Bear UL and FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.

D. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store valves in shipping containers, with labeling in place.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

PART 2 PRODUCTS

2.01 FIRE PROTECTION SYSTEMS

- A. Sprinkler Systems: Conform to NFPA 13.
- B. Welding Materials and Procedures: Conform to ASME BPVC-IX.

2.02 ABOVE GROUND PIPING

- A. Steel Pipe: Schedule 40, black.
 - 1. Steel Fittings: ASME B16.9, wrought steel, buttwelded or ASME B16.25, buttweld ends.
 - 2. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings and ASME B16.4, threaded fittings.
 - 3. Malleable Iron Fittings: ASME B16.3, threaded fittings and ASTM A47/A47M.
 - 4. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.
 - 5. Mechanical Formed Fittings: Carbon steel housing with integral pipe stop and O-ring pocked and O-ring, uniformly compressed into permanent mechanical engagement onto pipe.

2.03 PIPE HANGERS AND SUPPORTS

- A. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
- B. Hangers for Pipe Sizes 2 inches and Over: Carbon steel, adjustable, clevis.
- C. Vertical Support: Steel riser clamp.

2.04 MECHANICAL COUPLINGS

- A. Rigid Mechanical Couplings for Grooved Joints:
 - 1. Dimensions and Testing: Comply with AWWA C606.
 - 2. Minimum Working Pressure: 300 psig.
 - 3. Housing Material: Fabricate of ductile iron conforming to ASTM A536.
 - 4. Housing Coating: Factory applied orange enamel.
 - 5. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
 - 6. Bolts and Nuts: Hot dipped galvanized or zinc electroplated steel.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and foreign material, from inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

- A. Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13.
- B. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- C. Install piping to conserve building space, to not interfere with use of space and other work.
- D. Group piping whenever practical at common elevations.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.
- G. Pipe Hangers and Supports:
 - 1. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 2. Place hangers within 12 inches of each horizontal elbow.
 - 3. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 4. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 - 5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- H. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- I. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- J. Do not penetrate building structural members unless indicated.

K. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.03 CLEANING

- A. Upon completion of work, clean all parts of the installation.
- B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

SECTION 22 05 19 METERS AND GAGES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Flow meters.
- B. Thermometers and thermometer wells.

1.02 REFERENCE STANDARDS

- A. ASME B40.100 Pressure Gauges and Gauge Attachments; 2013.
- B. ASTM E1 Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014.
- C. ASTM E77 Standard Test Method for Inspection and Verification of Thermometers; 2014.

1.03 FIELD CONDITIONS

A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 PRODUCTS

2.01 STEM TYPE THERMOMETERS

- A. Manufacturers:
 - 1. H.O. Trerice.
 - 2. Weiss Instruments, Inc.
 - 3. Dwyer Instruments, Inc.
 - 4. Miljoco.
- B. Thermometers Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
 - 1. Size: 9 inch scale.
 - 2. Window: Clear glass.
 - 3. Stem: 3/4 inch NPT brass.
 - 4. Accuracy: 2 percent, per ASTM E77.
 - 5. Calibration: Degrees F.

2.02 THERMOMETER SUPPORTS

- A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
- B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- C. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- D. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- E. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.02 SCHEDULES

- A. Stem Type Thermometers, Location and Scale Range:
 - 1. Boilers inlets and outlets, 30 to 240 degrees F.
 - 2. Domestic hot water supply and recirculation, 0 to 160 degrees F.

SECTION 22 05 53 IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Pipe markers.

1.02 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2007.

1.03 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- C. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

- A. Piping: Pipe markers.
- B. Pumps: Nameplates.
- C. Small-sized Equipment: Tags.
- D. Valves: Tags.

2.02 NAMEPLATES

- A. Manufacturers:
 - 1. Brimar Industries, Inc..
 - 2. Kolbi Pipe Marker Co..
 - 3. Seton Identification Products.
 - 4. Craftmark Identification Systems.
- B. Description: Laminated three-layer plastic with engraved letters.
 - 1. Letter Color: Black.
 - 2. Letter Height: 1/2 inch.
 - 3. Background Color: White.
 - 4. Plastic: Conform to ASTM D709.

2.03 TAGS

- A. Manufacturers:
 - 1. Brimar Industries, Inc..

- 2. Kolbi Pipe Marker Co..
- 3. Seton Identification Products.
- 4. Craftmark Identification Systems.
- B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
- C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.04 PIPE MARKERS

- A. Manufacturers:
 - 1. Brimar Industries, Inc.
 - 2. Kolbi Pipe Marker Co..
 - 3. Seton Identification Products.
 - 4. Craftmark Identification Systems.
- B. Comply with ASME A13.1.
- C. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- E. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.
- F. Color code as follows:
 - 1. Potable, Cooling, Boiler, Feed, Other Water: Green with white letters.
 - 2. Flammable Fluids: Yellow with black letters.

PART 3 EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Install plastic pipe markers in accordance with manufacturer's instructions.
- D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- E. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- F. Use tags on piping 3/4 inch diameter and smaller.

- G. Identify pipe markers indicating service, flow direction, and pressure.
- H. Install pipe markers in clear view and align with axis of piping.
- I. Location of pipe identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

SECTION 22 07 19 PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping insulation.
- B. Jackets and accessories.

1.02 RELATED REQUIREMENTS

A. Section 22 10 05 - Plumbing Piping: Placement of hangers and hanger inserts.

1.03 REFERENCE STANDARDS

- A. ASTM C177 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2013.
- B. ASTM C195 Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2013).
- C. ASTM C547 Standard Specification for Mineral Fiber Pipe Insulation; 2015.
- D. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- E. ASTM E96/E96M Standard Test Methods for Water Vapor Transmission of Materials; 2014.
- F. UL 723 Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 QUALITY ASSURANCE

- A. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum three years of experience.
- B. Comply with the Midwest Insulation Contractors Association "National Commercial and Industrial Insulation Standards".

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.07 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER

A. Manufacturers:

- 1. CertainTeed Corporation.
- 2. Johns Manville Corporation.
- 3. Knauf Insulation.
- 4. Owens Corning Corporation.
- B. Insulation: ASTM C547 and ASTM C795; semi-rigid, noncombustible, end grain adhered to jacket.
 - 1. 'K' Value: ASTM C177, 0.24 at 75 degrees F.
 - 2. Maximum Service Temperature: 650 degrees F.
 - 3. Maximum Moisture Absorption: 0.2 percent by volume.
- C. Vapor Barrier Jacket: White Kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
- D. Vapor Barrier Lap Adhesive: Compatible with insulation.
- E. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.03 JACKETS

- A. PVC Plastic.
 - 1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil.
 - e. Connections: Brush on welding adhesive.
 - 2. Covering Adhesive Mastic: Compatible with insulation.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with North American Insulation Manufacturers Association (NAIMA) National Insulation Standards.
- C. Exposed Piping: Locate insulation and cover seams in least visible locations.
- D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints. All hangers, supports, anchors and other projections that are in contact to cold surfaces shall be insulated and vapor sealed to prevent condensation.
- E. Glass fiber insulated pipes conveying fluids below ambient temperature:
 - 1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- F. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- G. Glass fiber insulated pipes conveying fluids above ambient temperature:
 - 1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- H. Inserts and Shields:
 - 1. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 - 2. Insert Location: Between support shield and piping and under the finish jacket.
 - 3. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 4. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- I. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions.
- J. Apply insulation at pipe hangers and supports according to National Commercial and Industrial Standards Plate Numbers 5, 6 and 7.

3.03 SCHEDULES

- A. Plumbing Systems:
 - 1. Domestic Hot Water Supply:
 - a. Glass Fiber Insulation:
 - 1) Pipe Size Range: Up to and including 2 inch.

- a) Thickness: 1 inch.
- 2. Domestic Hot Water Recirculation:
 - a. Glass Fiber Insulation:
 - 1) Pipe Size Range: All sizes.
 - a) Thickness: 1 inch.
 - 2) PVC Jacket Color: White.
- 3. Domestic Cold Water:
 - a. Glass Fiber Insulation:
 - 1) Pipe Size Range: All sizes.
 - a) Thickness: 1 inch.
 - 2) PVC Jacket Color: Green.

SECTION 22 10 05 PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pipe, pipe fittings, specialties, and connections for piping systems.
 - 1. Sanitary sewer.
 - 2. Domestic water.
 - 3. Flanges, unions, and couplings.
 - 4. Pipe hangers and supports.
 - 5. Valves.
 - 6. Check.

1.02 RELATED REQUIREMENTS

- A. Section 22 05 53 Identification for Plumbing Piping and Equipment.
- B. Section 22 07 19 Plumbing Piping Insulation.

1.03 REFERENCE STANDARDS

- A. ANSI Z21.18/CSA 6.3 Gas Appliance Pressure Regulators; 2007 (Reaffirmed 2012).
- B. ANSI Z21.80/CSA 6.22 Line Pressure Regulators; 2011 (Including Addendum 1).
- C. ASME B16.3 Malleable Iron Threaded Fittings: Classes 150 and 300; 2011.
- D. ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
- E. ASME B16.22 Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.
- F. ASME B16.23 Cast Copper Alloy Solder Joint Drainage Fittings DWV; 2011.
- G. ASME B16.29 Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings DWV; 2012.
- H. ASSE 1003 Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems; 2009.
- I. ASTM A53/A53M Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- J. ASTM A74 Standard Specification for Cast Iron Soil Pipe and Fittings; 2015.
- K. ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
- L. ASTM B32 Standard Specification for Solder Metal; 2008 (Reapproved 2014).
- M. ASTM B88 Standard Specification for Seamless Copper Water Tube; 2014.
- N. ASTM B306 Standard Specification for Copper Drainage Tube (DWV); 2013.

- O. ASTM B813 Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2010.
- P. ASTM B828 Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2002 (Reapproved 2010).
- Q. ASTM C564 Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2014.
- R. ASTM D2513 Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings; 2014.
- S. ASTM D2564 Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2012.
- T. ASTM D2665 Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2014.
- U. ASTM D2683 Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing; 2014.
- V. ASTM D2855 Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings; 1996 (Reapproved 2010).
- W. AWWA C105/A21.5 Polyethylene Encasement for Ductile-Iron Pipe Systems; 2010.
- X. AWWA C550 Protective Interior Coatings for Valves and Hydrants; 2013.
- Y. AWWA C651 Disinfecting Water Mains; 2005.
- Z. CISPI 301 Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications; 2009.
- AA. CISPI 310 Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2011.
- AB. MSS SP-58 Pipe Hangers and Supports Materials, Design, Manufacture, Selection, Application, and Installation; 2009.
- AC. MSS SP-67 Butterfly Valves; 2011.
- AD. MSS SP-71 Cast Iron Swing Check Valves, Flanged and Threaded Ends; 2011.
- AE. MSS SP-78 Cast Iron Plug Valves, Flanged and Threaded Ends; 2011.
- AF. MSS SP-80 Bronze Gate, Globe, Angle and Check Valves; 2013.
- AG. MSS SP-110 Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010.
- AH. NSF 61 Drinking Water System Components Health Effects; 2014 (Errata 2015).
- Al. NSF 372 Drinking Water System Components Lead Content; 2011.
AJ.Safe Drinking Water Act, Section 1417 - Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content <= 0.25%, Amended January 4, 2011.

1.04 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- C. Project Record Documents: Record actual locations of valves.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with applicable codes.
- B. Valves: Manufacturer's name and pressure rating marked on valve body. Manufacturers lead free marking on valve body.
- C. Perform Work in accordance with City plumbing ordinances.
- D. Perform Work in accordance with Fox Metro Water Reclamation District (Sanitary sewer contractor shall be bonded with Fox Metro).

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.07 FIELD CONDITIONS

A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.02 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Cast Iron Pipe: ASTM A74 service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.
- B. Cast Iron Pipe: CISPI 301, hubless.
 - 1. Fittings: Cast iron.

- 2. Joints: CISPI 310, neoprene gasket and stainless steel clamp and shield assemblies.
- C. PVC Pipe: ASTM D2665 or ASTM D3034.
 - 1. Fittings: PVC.
 - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.03 SANITARY SEWER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: ASTM A74, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joint Seals: ASTM C564 neoprene gaskets, or lead and oakum.
- B. Cast Iron Pipe: CISPI 301, hubless, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.
- C. Copper Tube: ASTM B306, DWV.
 - 1. Fittings: ASME B16.29, wrought copper, or ASME B16.23, sovent.
 - 2. Joints: ASTM B32, alloy Sn50 solder.
- D. PVC Pipe: ASTM D2665.
 - 1. Fittings: PVC.
 - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.04 DOMESTIC WATER PIPING, ABOVE GRADE

- A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), Drawn (H).
 - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - 2. Joints: ASTM B32, alloy Sn95 solder.
 - Mechanical Press Sealed Fittings: Double pressed type, NSF 61 approved or certified, utilizing EPDM, non toxic synthetic rubber sealing elements. Sealing elements shall be factory installed by fitting manufacturer. Press ends shall have means to indicate non-pressed fitting during pressure testing.
 - a. Manufacturers:
 - 1) Viega LLC.
 - 2) Nibco.

2.05 NATURAL GAS PIPING, BURIED BEYOND 5 FEET OF BUILDING

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASTM A234/A234M, wrought steel welding type, with AWWA C105/A21.5 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.
 - 2. Joints: ASME B31.1, welded.
- B. Polyethylene Pipe: ASTM D2513, SDR 11.
 - 1. Fittings: ASTM D2683 or ASTM D2513 socket type.
 - 2. Joints: Fusion welded.

2.06 NATURAL GAS PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASTM A234/A234M, wrought steel welding type.

- 2. Joints: ASME B31.1, welded.
- 3. Jacket: AWWA C105/A21.5 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.

2.07 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
 - 2. Joints: Threaded or welded to ASME B31.1.

2.08 FLANGES, UNIONS, AND COUPLINGS

- A. Unions for Pipe Sizes 3 Inches and Under:
 - 1. Ferrous pipe: Class 150 malleable iron threaded unions.
 - 2. Copper tube and pipe: Class 150 bronze unions with soldered joints.
- B. Flanges for Pipe Size Over 1 Inch:
 - 1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
 - 2. Copper Tube and Pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.
- C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.09 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
 - 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 - 2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
 - 3. Trapeze Hangers: Welded steel channel frames attached to structure.
 - 4. Vertical Pipe Support: Steel riser clamp.
 - 5. Floor Supports: Concrete pier or steel pedestal with floor flange; fixture attachment.
 - 6. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
 - a. Bases: High density polypropylene.
 - b. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 - c. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
 - d. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
 - e. Height: Provide minimum clearance of 6 inches under pipe to top of roofing.
- B. Plumbing Piping Water:
 - 1. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
 - 2. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
 - 3. Hangers for Hot Pipe Sizes 2 Inches to 4 Inches: Carbon steel, adjustable, clevis.

- 4. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- 5. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.
- 6. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- C. Plumbing Piping Gas:
 - 1. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
 - 2. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.

2.10 BALL VALVES

- A. Manufacturers:
 - 1. Nibco, Inc; T/S-585-66-LF.
 - 2. Watts.
 - 3. Milwaukee Valve Company.
- B. Construction, 4 Inches and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze body, 304 stainless steel ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, solder, threaded, or grooved ends.

2.11 PLUG VALVES

- A. Up to and including 2 Inches (50 mm): bronze body, bronze tapered plug, non-lubricated, teflon packing, screwed ends.
- B. Construction 2-1/2 Inches and Larger: 1, 175 psi CWP, cast iron body and plug, pressure lubricated, teflon or Buna N packing, flanged or grooved ends. Provide lever operator with set screw.

2.12 LINE PRESSURE REGULATORS AND APPLIANCE REGULATORS INDICATORS

- A. Compliance Requirements:
 - 1. Appliance Regulator: ANSI Z21.18/CSA 6.3.
 - 2. Line Pressure Regulator: ANSI Z21.80/CSA 6.22.
- B. Materials in Contact With Gas:
 - 1. Housing: Aluminum, steel (free of non-ferrous metals).
 - 2. Seals and Diaphragms: NBR-based rubber.
- C. Maximum Inlet Operating Pressure: 10 psi.
 - 1. Appliance Regulator: 2 psi.
 - 2. Line Pressure Regulator: 10 psi.

2.13 BUTTERFLY VALVES

- A. Manufacturers:
 - 1. Crane Co..
 - 2. Nibco; Model LD 2000N-3/5.
 - 3. Watts.

B. Construction 1-1/2 Inches and Larger: MSS SP-67, 200 psi CWP, NSF61G, ductile iron body (ASTM A536, lead free aluminum bronze disc, geometric drive (one piece stainless steel stem, no pin through disc), resilient molded-in EPDM seat, lug ends suitable for bidirectional dead-end service rated pressure without use of downstream flange, extended neck, 10 position lever handle.

2.14 PIPING SPECIALTIES

- A. Flow Controls:
 - 1. Manufacturers:
 - a. ITT Bell & Gossett.
 - b. Griswold Controls.
 - c. Taco, Inc.
 - 2. Construction: Class 125, Brass or bronze body with union on inlet, temperature and pressure test plug on inlet and outlet.
 - 3. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi.

2.15 SWING CHECK VALVES

- A. Manufacturers:
 - 1. Milwaukee Valve Company.
 - 2. Nibco, Inc; S-413-Y-LF.
 - 3. Watts.
- B. Up to 2 Inches:
 - 1. MSS SP-139, 300 CWP, silicon bronze (ASTM Listed and corrosion resistant) body and cap designed for horizontal or vertical (flow in upward direction) flow, PFTE or TFE swing disc with rubber seat, solder ends.
- C. Over 2 Inches:
 - 1. MSS SP-71, 200 CWP, iron body (ASTM A126), stainless steel or silicon bronze swing disc (ASTM Listed and corrosion resistant) trim, renewable disc seal and seat, flanged or grooved ends.

2.16 WATER PRESSURE REDUCING VALVES

- A. Manufacturers:
 - 1. Amtrol Inc.
 - 2. Bell & Gossett.
 - 3. Watts Regulator Company.
- B. Up to 2 Inches:
 - 1. ASSE 1003, bronze body, stainless steel, and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded single union ends.
- C. Over 2 Inches:
 - 1. ASSE 1003, cast iron body with interior lining complying with AWWA C550, bronze fitted, elastomeric diaphragm and seat disc, flanged.

2.17 STRAINERS

- A. Size 2 inch and Under:
 - 1. Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
 - 2. Class 150, threaded bronze body 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- D. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- H. Provide access where valves and fittings are not exposed.
- I. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.
- J. Install valves with stems upright or horizontal, not inverted. Refer to Section 22 05 23.
- K. Pipe vents from gas pressure reducing valves to outdoors and terminate in weather proof hood.
- L. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.
- M. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
- N. Sleeve pipes passing through partitions, walls and floors.
- O. Provide sleeve and watertight mechanical seal on all wall penetration.

- P. Pipe Hangers and Supports:
 - 1. Support horizontal piping as indicated.
 - 2. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 3. Place hangers within 12 inches of each horizontal elbow.
 - 4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 - 6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 7. Provide copper plated hangers and supports for copper piping.
 - 8. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.04 APPLICATION

- A. Use grooved mechanical couplings and fasteners only in accessible locations.
- B. Install unions downstream of valves and at equipment or apparatus connections.
- C. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- D. Install ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- E. Install ball or butterfly valves for throttling, bypass, or manual flow control services.
- F. Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.
- G. Provide plug valves in natural gas systems for shut-off service.
- H. Provide flow controls in water recirculating systems where indicated.

3.05 TOLERANCES

A. Water Piping: Slope at minimum of 1/32 inch per foot and arrange to drain at low points.

3.06 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Prior to starting work, verify system is complete, flushed and clean.
- B. Ensure acidity (pH) of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
- D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
- E. Maintain disinfectant in system for 24 hours.
- F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

- G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
- H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.07 SCHEDULES

- A. Pipe Hanger Spacing:
 - 1. Metal Piping:
 - a. Pipe Size: 1/2 inches to 1-1/4 inches:
 - 1) Maximum Hanger Spacing: 6.5 ft.
 - 2) Hanger Rod Diameter: 3/8 inches.
 - b. Pipe Size: 1-1/2 inches to 2 inches:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 3/8 inch.
 - c. Pipe Size: 2-1/2 inches to 3 inches:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 1/2 inch.
 - d. Pipe Size: 4 inches to 6 inches:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 5/8 inch.
 - 2. Plastic Piping:
 - a. All Sizes:
 - 1) Maximum Hanger Spacing: 6 ft.
 - 2) Hanger Rod Diameter: 3/8 inch.

END OF SECTION

SECTION 22 10 06 PLUMBING PIPING SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Drains.
- B. Backflow preventers.
- C. Mixing valves.
- D. Air vents.

1.02 RELATED REQUIREMENTS

- A. Section 22 10 05 Plumbing Piping.
- B. Section 22 30 00 Plumbing Equipment.

1.03 REFERENCE STANDARDS

- A. ASME A112.6.3 Floor and Trench Drains; 2001 (R2007).
- B. ASSE 1012 Backflow Preventer with Intermediate Atmospheric Vent; 2009.
- C. ASSE 1013 Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers; 2011.
- D. ASSE 1019 Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance; 2011.
- E. NSF 61 Drinking Water System Components Health Effects; 2014 (Errata 2015).
- F. NSF 372 Drinking Water System Components Lead Content; 2011.
- G. PDI-WH 201 Water Hammer Arresters; 2010.

1.04 SUBMITTALS

- A. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
- B. Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, water hammer arrestors.
- C. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept specialties on site in original factory packaging. Inspect for damage.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Specialties in Potable Water Supply Systems: Provide products that comply with NSF 61 and NSF 372 for maximum lead content.

2.02 DRAINS

- A. Manufacturers:
 - 1. Jay R. Smith Manufacturing Company.
 - 2. Zurn Industries, Inc.
 - 3. MIFAB.
- B. Floor Drain FD-1:
 - 1. ASME A112.6.3; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and 9 inch round, medium duty ductile iron bar grate.
 - 2. Zurn; Model Z550-DG.

2.03 BACKFLOW PREVENTERS (RPZBP-1)

- A. Manufacturers:
 - 1. Watts Regulator Company.
 - 2. Zurn/Wilkins Industries, LLC.
 - 3. Febco.
- B. Reduced Pressure Backflow Preventers:
 - ASSE 1013; 1 inch bronze body with bronze internal parts and stainless steel springs; two
 independently operating, spring loaded check valves; diaphragm type differential pressure relief
 valve located between check valves; third check valve that opens under back pressure in case
 of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and
 four test cocks.
 - 2. Zurn; Model 375XL

2.04 AIR VENTS

- A. Manufacturers:
 - 1. Armstrong International, Inc.
 - 2. ITT Bell & Gossett.
 - 3. Taco, Inc.
- B. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
- C. Float Type:
 - 1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
 - 2. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

2.05 MIXING VALVES

- A. Thermostatic Mixing Valve (TMV-1):
 - 1. Manufacturers:
 - a. Powers.
 - b. Leonard Valve Company.

- c. Lawler.
- d. Symmons.
- 2. Valve: ASSE 1017; Chrome plated cast brass body, thermal actuator, integral temperature adjustment.
- 3. Capacity: 16 gpm at 20 psi differential.
 - a. TMV-1 14.6 gpm at 10 psi differential. Powers Model LFMM431.
 - b. TMV-2 16.8 gpm at 10 psi differential. Powers Model LFMM431.
 - c. TMV-3 17.0 gpm at 10 psi differential. Powers Model LFMM431.
 - d. TMV-4 14.6 gpm at 10 psi differential. Powers Model LFMM431.
- 4. Accessories:
 - a. Check valve on inlets.
 - b. Stem thermometer on outlet.
 - c. Strainer stop checks on inlets.
- 5. Cabinet: 16 gage enameled steel, for surface mounting with keyed lock.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibbs.
- C. Pipe relief from backflow preventer to nearest drain.

END OF SECTION

SECTION 22 30 00 PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Water heating systems.
- B. Diaphragm-type compression tanks.
- C. In-line circulator pumps.

1.02 RELATED REQUIREMENTS

A. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. ANSI Z21.10.1 Gas Water Heaters Volume I Storage Water Heaters with Input Ratings of 75,000 Btu per Hour or Less; 2011.
- B. ASME BPVC-VIII-1 Boiler and Pressure Vessel Code, Section VIII, Division 1 Rules for Construction of Pressure Vessels; 2015.

1.04 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittals procedures.
- B. Product Data:
 - 1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
 - 2. Indicate pump type, capacity, power requirements.
 - 3. Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
 - 4. Provide electrical characteristics and connection requirements.
- C. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
- D. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Certifications:

- 1. Water Heaters: NSF approved.
- 2. Gas Water Heaters: Certified by CSA International to ANSI Z21.10.1, as applicable, in addition to requirements specified elsewhere.
- 3. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

C. Performance: Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

1.06 DELIVERY, STORAGE, AND HANDLING

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

1.07 WARRANTY

A. Provide five year manufacturer limited warranty for water heater and storage tank.

PART 2 PRODUCTS

2.01 WATER HEATING SYSTEMS

- A. Manufacturers:
 - 1. Lochinvar LLC; Model Armor..
 - 2. Raypak.
 - 3. Laars.
- B. System: Gas-fired direct heating boiler, circulating pump, controls, piping and valving as indicated, storage tank.
- C. Boiler:
 - The water heater shall bear the ASME "HLW" stamp and shall be National Board listed for inputs in excess of 200,000 Btu/Hr. There shall be no banding material, bolts, gaskets or "O" rings in the header configuration. The water heater shall have direct spark ignition with electonic supervision. The stainless steel combustion chamber shall be designed to drain condensation to the bottom of the heat exchanger assembly. A built-in trap shall allow condensation to drain from the heat exchanger assembly.
 - 2. The water heater shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.10.3 test standard for the US and Canada. The water heater shall comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard. The water heater shall be AHRI certified to 96% thermal efficiency. The water heater shall be certified for indoor installation.
 - 3. The water heater shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. A burner/flame observation port shall be provided. The burner shall be a premix design and constructed of high temperature stainless steel with a woven metal fiber outer covering to provide modulating firing rates. The water heater shall be supplied with a gas valve designed with negative pressure regulation and be equipped with a variable speed blower system, to precisely control the fuel/air mixture to provide modulating water heater firing rates for maximum efficiency. The water heater shall operate in a safe condition at a derated output with gas supply pressures as low as 4 inches of water column.
 - 4. The water heater shall utilize a 24 VAC control circuit and components. The control system shall have an electronic display for water heater set-up, water heater status, and water heater diagnostics. All components shall be easily accessed and serviceable from the front and top of

the jacket. The water heater shall be equipped with; a high limit temperature control certified to UL353, ASME certified pressure relief valve, outlet water temperature sensor, inlet water temperature sensor, a UL 353 certified flue temperature sensor, low water flow protection and built-in freeze protection. The manufacturer shall verify proper operation of the burner, all controls and the heat exchanger by connection to water and venting for a factory fire test prior to shipping.

- 5. The water heater shall feature the "Smart System" control with a Multi-Colored Graphic LCD display with Navigation Dial and Soft Keys, password security, pump delay with freeze protection, pump exercise, and USB PC port connection. The water heater shall feature night setback for the domestic hot water tank and shall be capable of controlling a building recirculation pump while utilizing the night setback schedule for the building recirculation pump. The water heater shall have the capability to accept a 0-10 VDC input connection for BMS control of modulation or setpoint and enable/disable of the water heater, and a 0-10VDC output of water heater modulation rate. The water heater shall have a built-in cascading sequencer with modulation logic options of "lead lag" or "efficiency optimized". Both modulation logic options should be capable of rotation while maintaining modulation of up to eight water heaters without utilization of an external controller. Supply voltage shall be 120 volt / 60 hertz / single phase.
- 6. The water heater shall be equipped with two terminal strips for electrical connection. A low voltage connection board with data points for safety and operating controls, i.e., Auxiliary Relay, Auxiliary Proving Switch, Alarm Contacts, Runtime Contacts, Manual Reset Low Water Cutoff, Flow Switch, High and Low Gas Pressure Switches, Tank Thermostat, Tank Sensor, Building Management System Signal, Modbus Control Contacts and Cascade Control Circuit. A high voltage terminal strip shall be provided for supply voltage. The high voltage terminal strip plus integral relays are provided for independent control of the domestic hot water pump and building re-circulation pump.
- 7. Venting;
 - a. Direct Vent Sidewall system with a horizontal sidewall termination of both the vent and combustion air. The flue shall be PVC, CPVC or Stainless Steel sealed vent material terminating at the sidewall with the manufacturers specified vent termination. A separate pipe shall supply combustion air directly to the WATER HEATER from the outside. The air inlet pipe may be PVC, CPVC, ABS, Galvanized, or Stainless Steel sealed pipe. The air inlet must terminate on the same sidewall with the manufacturer's specified air inlet cap. The water heater's total combined air intake length shall not exceed 100 equivalent feet. The water heater's total combined exhaust venting length shall not exceed 100 equivalent feet.
 - b. Direct Vent Vertical system with a vertical roof top termination of both the vent and combustion air. The flue shall be PVC, CPVC or Stainless Steel sealed vent material terminating at the roof top with the manufacturers specified vent termination. A separate pipe shall supply combustion air directly to the WATER HEATER from the outside. The air inlet pipe may be PVC, CPVC, ABS, Galvanized, Dryer Vent, or Stainless Steel sealed pipe. The air inlet must terminate on the roof top with the manufacturer's specified air inlet cap. The WATER HEATER's total combined air intake length shall not exceed 100 equivalent feet.

8. Performance: As scheduled on Drawings.

D. Vertical storage tank:

- 1. Overall Length: 62 inches.
- 2. Diameter: 28 inches.
- 3. Nominal Capacity: 119 gal.
- 4. Lochinvar; Model RJA120A.
- 5. The storage shall be constructed in accordance with ASME requirements, stamped and registered with the National Board of Boiler and Pressure Vessel Inspectors. The storage tank shall have a working pressure of 150 psi. The storage tank shall be glass lined and fired to 1600°F to ensure a molecular fusing of glass and steel. The Lock-Temp Tank shall be constructed with a heavy gauge galvanized steel jacket assembly, primed and pre-painted on both sides. The jacket and tank base shall be a water tight construction with a built-in drain pan, complete with a ³/₄" drain connection to assist in protecting against damage in the event of a tank or component leakage. The storage tank shall be completely encased in high density insulation of sufficient thickness to meet the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard.
- E. Pump:
 - 1. The circulating shall be all bronze and operate on a 120 volt, 60 cycle, 1 phase power supply. The pump shall be wired to run with intermittent pump operation.

2.02 DIAPHRAGM-TYPE COMPRESSION TANKS

- A. Manufacturers:
 - 1. Amtrol Inc.
 - 2. ITT Bell & Gossett.
 - 3. Watts.
- B. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, rated for working pressure of 125 psig, with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.
- C. Accessories: Pressure gage and air-charging fitting, tank drain; precharge to 12 psig.
- D. Size as scheduled on the Drawings.

2.03 IN-LINE CIRCULATOR PUMPS

- A. Manufacturers:
 - 1. Armstrong Pumps Inc.
 - 2. ITT Bell & Gossett; Model PL-30B.
 - 3. Taco, Inc.
- B. Casing: Lead free bronze, rated for 150 psig working pressure,
- C. Impeller: 30% glass filled Noryl
- D. Shaft: Solid high-strength alloy steel.
- E. Bearings: Permanently lubricated sealed precision bearings.

- F. Drive: Close coupled, ODP motor.
- G. Accessories: UL approved automatic timer kit to provide automatic ON-OFF control at minimum 15 minute intervals. B&G Model TC-1.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.
- B. Coordinate with plumbing piping and related fuel piping, gas venting, and electrical work to achieve operating system.
- C. Pumps:
 - 1. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

END OF SECTION

SECTION 23 05 19 METERS AND GAGES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pressure gages and pressure gage taps.
- B. Thermometers and thermometer wells.

1.02 RELATED REQUIREMENTS

- A. Section 23 09 23 Direct-Digital Control System for HVAC.
- B. Section 23 21 13 Hydronic Piping.

1.03 REFERENCE STANDARDS

- A. ASME B40.100 Pressure Gauges and Gauge Attachments; 2013.
- B. ASTM E1 Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014.
- C. ASTM E77 Standard Test Method for Inspection and Verification of Thermometers; 2014.
- D. UL 393 Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
- B. Project Record Documents: Record actual locations of components and instrumentation.

1.05 FIELD CONDITIONS

A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 PRODUCTS

2.01 PRESSURE GAGES

- A. Pressure Gages: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
 - 1. Case: Steel with brass bourdon tube.
 - 2. Size: 4-1/2 inch diameter.
 - 3. Mid-Scale Accuracy: One percent.
 - 4. Scale: Psi.

2.02 PRESSURE GAGE TAPPINGS

A. Gage Cock: Tee or lever handle, brass for maximum 150 psi.

2.03 STEM TYPE THERMOMETERS

A. Manufacturers:

- 1. Dwyer Instruments, Inc.
- 2. Omega Engineering, Inc.
- 3. Weksler Glass Thermometer Corp.
- 4. Miljoco Corporation.
- B. Thermometers Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
 - 1. Size: 9 inch scale.
 - 2. Window: Clear shatter proof polycarbonate.
 - 3. Stem: 2.5 inches NPT brass
 - 4. Accuracy: 2 percent, per ASTM E77.
 - 5. Calibration: Degrees F.

2.04 THERMOMETER SUPPORTS

- A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
- B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.05 TEST PLUGS

- A. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F.
- B. Test Kit: Carrying case, internally padded and fitted containing one 2-1/2 inch diameter pressure gages, one gage adapters with 1/8 inch probes, two 1 inch dial thermometers.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- C. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- D. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- E. Locate test plugs adjacent thermometers and thermometer sockets.

3.02 SCHEDULE

- A. Pressure Gages, Location and Scale Range:
 - 1. Pumps, 0 to 60 psi.

- 2. Expansion tanks, 0 to 60 psi.
- B. Pressure Gage Tappings, Location:
 - 1. Heat exchangers inlets and outlets.
 - 2. Boiler inlets and outlets.
- C. Stem Type Thermometers, Location and Scale Range:
 - 1. Heat exchangers inlets and outlets, 0 to 240 degrees F.
 - 2. Boilers inlets and outlets, 30 to 240 degrees F.
 - 3. Water zone supply and return, 0 to 240 degrees F.
- D. Thermometer Sockets, Location:
 - 1. Unit heaters inlets and outlets.

END OF SECTION

SECTION 23 05 53 IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Pipe markers.

1.02 REFERENCE STANDARDS

- A. ASME A13.1 Scheme for the Identification of Piping Systems; 2007.
- B. ASTM D709 Standard Specification for Laminated Thermosetting Materials; 2013.

1.03 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements for submittal procedures.
- B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- C. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

- A. Control Panels: Nameplates.
- B. Heat Transfer Equipment: Nameplates.
- C. Instrumentation: Tags.
- D. Major Control Components: Nameplates.
- E. Piping: Pipe markers.
- F. Pumps: Nameplates.
- G. Valves: Tags.

2.02 NAMEPLATES

- A. Manufacturers:
 - 1. Brimar Industries, Inc.
 - 2. Kolbi Pipe Marker Co..
 - 3. Seton Identification Products.

2.03 TAGS

- A. Manufacturers:
 - 1. Brady Corporation.
 - 2. Brimar Industries, Inc.

- 3. Kolbi Pipe Marker Co..
- 4. Seton Identification Products.
- B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
- C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.04 PIPE MARKERS

- A. Manufacturers:
 - 1. Brady Corporation.
 - 2. Brimar Industries, Inc.
 - 3. Kolbi Pipe Marker Co..
 - 4. Seton Identification Products.
- B. Color: Conform to ASME A13.1.
- C. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- E. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.
- F. Color code as follows:
 - 1. Heating, Cooling, and Boiler Feedwater: Green with white letters.

PART 3 EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION

- A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Install plastic pipe markers in accordance with manufacturer's instructions.
- D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- E. Use tags on piping 3/4 inch diameter and smaller.
- F. Identify pipe service, flow direction, and pressure.
- G. Install pipe markers in clear view and align with axis of piping.

H. Location of pipe identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

END OF SECTION

SECTION 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Testing, adjustment, and balancing of hydronic systems.
- B. Measurement of final operating condition of HVAC systems.

1.02 REFERENCE STANDARDS

- A. AABC (NSTSB) AABC National Standards for Total System Balance, 7th Edition; 2016.
- B. ASHRAE Std 111 Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2008.
- C. NEBB (TAB) Procedural Standards for Testing Adjusting Balancing of Environmental Systems; 2005, Seventh Edition.
- D. SMACNA (TAB) HVAC Systems Testing, Adjusting and Balancing; 2002.

1.03 SUBMITTALS

- A. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
- B. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - 1. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - 2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect/Engineer and for inclusion in operating and maintenance manuals.
 - 3. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - 4. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 - 5. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.
 - 6. Include the following on the title page of each report:
 - a. Name of Testing, Adjusting, and Balancing Agency.
 - b. Address of Testing, Adjusting, and Balancing Agency.
 - c. Telephone number of Testing, Adjusting, and Balancing Agency.
 - d. Project name.
 - e. Project location.
 - f. Project Architect/Engineer.
 - g. Project Contractor.
 - h. Report date.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
 - 1. AABC (NSTSB), AABC National Standards for Total System Balance.
 - 2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
 - 3. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.
 - 4. SMACNA (TAB).
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. TAB Agency Qualifications:
 - 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 - 2. Having minimum of three years documented experience.
 - 3. Certified by one of the following:
 - a. AABC, Associated Air Balance Council: www.aabc.com; upon completion submit AABC National Performance Guaranty.
 - b. NEBB, National Environmental Balancing Bureau: www.nebb.org.
 - c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org.
- D. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.02 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Hydronic systems are flushed, filled, and vented.
 - 5. Pumps are rotating correctly.
 - 6. Proper strainer baskets are clean and in place.
 - 7. Service and balance valves are open.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- C. Beginning of work means acceptance of existing conditions.

3.03 ADJUSTMENT TOLERANCES

A. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.04 RECORDING AND ADJUSTING

- A. Ensure recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.05 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gages to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.06 SCOPE

- A. Test, adjust, and balance the following:
 - 1. Plumbing Pumps.
 - 2. HVAC Pumps.
 - 3. Packaged Steel Fire Tube Boilers.
 - 4. Terminal Heat Transfer Units.

END OF SECTION

SECTION 23 07 19 HVAC PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping insulation.
- B. Jackets and accessories.

1.02 RELATED REQUIREMENTS

A. Section 23 21 13 - Hydronic Piping: Placement of hangers and hanger inserts.

1.03 REFERENCE STANDARDS

- A. ASTM C177 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2013.
- B. ASTM C518 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2010.
- C. ASTM C547 Standard Specification for Mineral Fiber Pipe Insulation; 2015.
- D. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- E. ASTM E96/E96M Standard Test Methods for Water Vapor Transmission of Materials; 2014.
- F. UL 723 Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- B. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum three years of experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.07 FIELD CONDITIONS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER

A. Manufacturers:

- 1. CertainTeed Corporation.
- 2. Johns Manville Corporation.
- 3. Knauf Insulation.
- 4. Owens Corning Corporation.
- B. Insulation: ASTM C547; rigid molded, noncombustible.
 - 1. 'K' Value: ASTM C177, 0.23 at 75 degrees F.
 - 2. Maximum Service Temperature: 650 degrees F.
 - 3. Maximum Moisture Absorption: 0.2 percent by volume.
- C. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
- D. Vapor Barrier Lap Adhesive: Compatible with insulation.
- E. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

2.03 JACKETS

- A. PVC Plastic.
 - 1. Manufacturers:
 - a. Johns Manville Corporation.
 - b. Proto Corporation.
 - 2. Jacket: One piece molded type fitting covers and sheet material, color as scheduled.
 - a. Minimum Service Temperature: 0 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil.
 - e. Connections: Brush on welding adhesive.
 - 3. Covering Adhesive Mastic: Compatible with insulation.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Exposed Piping: Locate insulation and cover seams in least visible locations.
- D. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
- E. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- F. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
- G. Inserts and Shields:
 - 1. Application: Piping 1-1/2 inches diameter or larger.
 - 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 - 3. Insert location: Between support shield and piping and under the finish jacket.
 - 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- H. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 00.
- I. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions.

3.03 SCHEDULE

- A. Heating Systems:
 - 1. Heating Water Supply and Return:
 - a. Glass Fiber Insulation:
 - 1) Pipe Size Range: Up to and including 1-1/2 inch.
 - a) Thickness: 1-1/2 inch.
 - 2) Pipe Size Range: 2 inch and above.
 - a) Thickness: 2 inch.
 - 2. Glycol Heating Supply and Return:
 - a. Glass Fiber Insulation:
 - 1) Pipe Size Range: Up to and including 1-1/2 inch.
 - a) Thickness: 1-1/2 inch
 - 2) Pipe Size Range: 2 inch and above.
 - a) Thickness: 2 inch

END OF SECTION

SECTION 23 09 13 INSTRUMENTS AND CONTROL ELEMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Control panels.
- B. Input/Output Sensors:
 - 1. Temperature sensors.
 - 2. Equipment operation (current) sensors.

C. Transmitters:

- 1. Water pressure transmitters (liquid differential pressure transmitters).
- 2. Temperature transmitters.

D. Flow Sensors:

- 1. Insertion turbine meters.
- 2. Gas flow meters.

1.02 RELATED REQUIREMENTS

- A. Section 23 09 23 Direct-Digital Control System for HVAC.
- B. Section 23 21 13 Hydronic Piping: Installation of control valves, flow switches, temperature sensor sockets, gage taps.
- C. Section 26 27 17 Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

1.04 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
- C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.
- D. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

1.05 QUALITY ASSURANCE

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

PART 2 PRODUCTS

2.01 EQUIPMENT - GENERAL

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

2.02 CONTROL PANELS

- A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gages, pilot lights, push buttons and switches flush on cabinet panel face.
- B. NEMA 250, general purpose utility enclosures with enameled finished face panel.
- C. Provide common keying for all panels.

2.03 CONTROL VALVES

- A. Manufacturers.
 - 1. Danfoss; Model AB-QM.
 - 2. Flow Control Industries; Model DeltaPValve.
 - 3. Substitutions: See Section 01600 Product Requirements.
- B. Pressure Independent Control Valve.
 - 1. ASME B16.34 or ASME B16.15, valve bodies shall be two-way normally open or closed. Valve bodies 2 inches and smaller shall be bronze or brass. Valve bodies 2-1/2 inches and larger shall be brass, bronze or iron.
 - Valve shall be two way globe style, pressure independent, with integrated differential pressure control regulator. Regulation control of pressure shall be by an integrated EPDM diaphragm design, stainless spring, pressure control disc and require no internal maintenance or replaceable cartridges. Pressure control seat shall be brass construction with vulcanized EPDM.
 - 3. Provide user adjustable maximum flow within valve control range; adjustment method shall indicate percentage of valve flow range and utilize spring locked method of adjustment.
 - 4. Regulation of internal control valve differential pressure shall provide 100% control valve authority and maintain a linear flow characteristic.
 - 5. Flow shall be accurately controlled from 0-100% full rated flow with an operating pressure differential range of 4 to 60 psig.
 - 6. Valve shall provide back seated globe design to allow service of packing under pressure without leakage for valves up to 1-1/4 inches.
 - 7. Valve shall include PT test ports.
 - 8. Actuator shall operate the valve through its' full range and have a minimum close off pressure of 90 psig; have the ability to supply on/off, floating, proportional, safety spring and or feedback options; visible position indication; thermostatic, thermal or electronic version as indicated. Actuator shall be from the same manufacturer as the valve manufacturer.
- C. Butterfly Pattern:
 - 1. Iron body, bronze disc, resilient replaceable seat for service to 180 degrees F wafer or lug ends, extended neck.

- 2. Hydronic Systems:
 - a. Rate for service pressure of 125 psig at 250 degrees F.
 - b. Size for 1 psig maximum pressure drop at design flow rate.
- D. Electronic Operators:
 - 1. Valves shall spring return to normal position as indicated on freeze, fire, or temperature protection.
 - 2. Select operator for full shut off at maximum pump differential pressure.
- E. Radiation Valves:
 - 1. Bronze body, bronze trim, 2 or 3 port as indicated, replaceable plugs and seats, union and threaded ends.
 - 2. Rate for service pressure of 125 psig at 250 degrees F.
 - 3. Size for 3 psig maximum pressure drop at design flow rate.
 - 4. Two way valves shall have equal percentage characteristics, three way valves linear characteristics. Size two way valve operators to close valves against pump shut off head.
 - 5. Operators (2 Position): Synchronous motor with enclosed gear train, dual return springs, valve position indicator; 24 v DC, 0.4 amp. Valves shall spring return to normal position for temperature protection.
 - 6. Operators (Modulating): Self contained, linear motorized actuator with approximately 3/4 inch stroke, 60 second full travel with transformer and SPDT contacts: 24 v DC, 6 watt maximum input.

2.04 INPUT/OUTPUT SENSORS

- A. Temperature Sensors:
 - 1. Use thermistor or RTD type temperature sensing elements with characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy.
 - 2. Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F.
 - 3. 100 ohm platinum RTD is acceptable if used with project DDC controllers.
 - 4. Temperature Sensing Device: Compatible with project DDC controllers.
 - 5. Performance Characteristics:
 - a. RTD:
 - 1) Range: Minus 40 degrees F through 220 degrees F minimum.
 - b. Temperature Transmitter:
 - 1) Accuracy: 0.10 degree F minimum or plus/minus 0.20 percent of span.
 - 2) Output: 4 to 20 mA.
 - c. Sensing Range:
 - 1) Use RTD type sensors for extended ranges beyond minus 30 degrees F to 230 degrees F.
 - 2) Use temperature transmitters in conjunction with RTD's when RTD's are incompatible with DDC controller direct temperature input.
 - d. Wire Resistance:
 - Use appropriate wire size to limit temperature offset due to wire resistance to 1.0 degree F or use temperature transmitter when offset is greater than 1.0 degree F due to wire resistance.

- 2) Compensate for wire resistance in software input definition when feature is available in the DDC controller.
- e. Immersion Temperature Sensors: A sensor encased in a corrosion-resistant probe with an indoor junction box service entry body.
- f. Insertion Elements:
 - 1) Provide dry type, insertion elements for liquids, installed in immersion wells, with minimum insertion length of 2.5 inches.
- B. Equipment Operation (Current) Sensors:
 - 1. Status Inputs for Pumps: Differential pressure switch piped across pump with adjustable pressure differential range of 8 to 60 psi.
 - 2. Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.

2.05 FLOW SENSORS

- A. Insertion Turbine Flow Meters:
 - 1. Manufacturers:
 - a. Onicon;Model F1210.
 - 2. Furnish dual axial turbine flowmeter with all installation hardware required to enable insertion and removal of the meter without system shutdown.
 - 3. All Parts: Meet or exceed the pressure classification of the piping system installed in.
 - 4. Accuracy for the Insertion Turbine Flow Meter: Plus/minus 0.5 percent of the rate at calibrated velocity, within plus/minus of the rate over a 10 to 1 turn down and within plus/minus 2 percent of the rate over a 50 to 1 turn down.
 - 5. Repeatability: Plus/minus 0.25 percent of reading.
 - 6. The meter flow sensing element to operate over a range suitable for the installed location with a pressure loss limited to 1 percent of operating pressure at maximum flow rate.
 - 7. Include dry contact outputs, 4 to 20 mA, 0 to 10 VDC.
 - 8. Fabricate the turbine rotor assembly of Series 300 stainless steel and use Teflon seats.
- B. Gas Flow Meters:
 - 1. Manufacturers:
 - a. Onicon; Model F-5500 Series .
 - 2. Thermal mass flow utilizing direct digital control sensing circuitry. Sensor measures mass flow directly and does not required additional pressure or temperature compensation to deliver accurate flow rate and total data. User friendly interface/display.
 - 3. Input power: 12-28 VDC, 6W minimum power.
 - 4. Pressure drop:
 - 5. Programming/memory: Factory programming for specific application. Field programming through user interface or mini-USB interface and utility program. Non=volatile memory retains all program parameters and totalized values in the event of power loss.
 - 6. Output Signals: Analog outputs; 4-20 mA, RS485 interface.
 - 7. Flow meter shall be wet calibrated in a flow laboratory against standards traceable to NIST. Certificate of calibration shall accompany meter.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that systems are ready to receive work.
- C. Beginning of installation means installer accepts existing conditions.
- D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
- E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.
- F. Ensure installation of components is complementary to installation of similar components.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide separable sockets for liquids and flanges for air bulb elements.
- C. Provide valves with position indicators and with pilot positioners where sequenced with other controls.
- D. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.
- E. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
- F. Provide conduit and electrical wiring in accordance with Section 26 27 17. Electrical material and installation shall be in accordance with appropriate requirements of Division 26. END OF SECTION

SECTION 23 09 23 DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. System description.
- B. Operator interface.
- C. Controllers.
- D. Power supplies and line filtering.
- E. System software.
- F. Controller software.
- G. HVAC control programs.

1.02 RELATED REQUIREMENTS

A. Section 23 09 13 - Instruments and Control Elements.

1.03 REFERENCE STANDARDS

- A. MIL-STD-810 Environmental Engineering Considerations and Laboratory Tests; Revision G, 2014.
- B. NFPA 70 National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Expand building Delta Controls Enteliweb Enterprise building control system to interface with new equipment and perform the sequence of operation specified. Modify automation system graphics to delete removed equipment and add new equipment.
- B. Provide a color graphical representation of all systems. The graphical display shall include all points indicated in the pints list and any others required to achieve the sequences of operation. The graphical user interface shall consist of the following as a minimum;
 - 1. Menu bar navigation via windows-like bars.
 - 2. Navigation will also be available via an image of the building profile from which the user clicks on floors to bring up individual floor plans.
 - 3. The individual floor plan zones shall change color based upon the difference between the actual zone temperature and zone set point so that the operator can tell at a glance if zones are in, above or below acceptable ranges. A minimum of five (5) colors are required: Color 1 = within acceptable range of set point, Color 2 = warning zone is above acceptable range of set point and approaching high temperature alarm; Color 3 = zone is in high temperature alarm; Color 4 = warning zone is below acceptable range of set point and approaching low temperature alarm; Color 5 = zone is in low temperature alarm.
 - 4. Clicking on a floor plan zone shall bring up a dynamic color graphic of the mechanical equipment that serves that zone.

- 5. Each major piece of mechanical equipment (terminal unit, AHU, boiler, chillers, cooling towers, etc.) shall have a pictorial dynamic color graphic. The central plant equipment may be combined as appropriate on one or more graphic page.
- 6. Text-based (non-pictorial) summary screens will also be provided so that the operator may view critical information on multiple units at once. Summary screens will be provided for terminal units and air handling units. Summary screens for VAV/FPVAV boxes will contain as a minimum room temperature, room temperature set point, occ/unocc status and CFM for each box. Summary screens for AHUs will contain as a minimum space temperature (CV units) or discharge temperature (VAV units) and the corresponding set point, static pressure (VAV units), OA damper position, mixed air temperature, fan status and occ/unocc status.
- 7. Clicking on a unit on any summary screen shall bring up the complete graphic for that unit.
- 8. Outside air temperature shall be displayed on each graphic screen.

1.05 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

- A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate both the ANSI/ASHRAE Standard 135-1995 BACnet and LonWorks technology communication protocols in one open, interoperable system.
- B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI/ASHRAE Standard 135-1995, BACnet and LonMark to assure interoperability between all system components is required. For each LonWorks device that does not have LonMark certification, the device supplier must provide a XIF file for the device. For each BACnet device, the device supplier must provide a PICS document showing the installed device = s-compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet.
- C. All components and controllers supplied under this contract shall be true peer-to-peer communicating devices. Components or controllers requiring polling by a host to pass data shall not be acceptable.
- D. The supplied system must incorporate the ability to access all data using Java enabled browsers without requiring proprietary operator interface and configuration programs. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable.
- E. The installed system shall provide secure password access to all features, functions and data contained in the overall Building Management Control System (BMCS). Secure Socket Layer (SSL) encryption shall be an available option for remote access.
- F. The installed system must be totally scalable to allow for future expansion with the addition of controllers and/or input/output devices. It shall not be necessary to remove equipment supplied under this contract to expand the system.
- G. The failure of any single component or network shall not interrupt the control functions of non-affected devices. A single network failure shall only affect shared communications or shared

data; individual application controllers and network controllers shall continue normal operation minus only the data from a remote device from the affected network. Automatic default values for all network transported data shall be provide to allow continued operation until the network is restored.

- H. The BMCS shall provide support for ODBC or SQL. An embedded database must be an ODBC-compliant database or must provide an ODBC data access mechanism to read and write dated stored within it. A minimum offering would be the documentation of database schemes to allow users to read/write data into other applications using appropriate ODBS syntax.
- I. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data.
 - 1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
 - 2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

1.06 WEB BROWSER CLIENTS

- A. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacturer-specific browsers shall not be acceptable.
- B. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the BMCS shall not be acceptable.
- C. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface (GUI). Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
- D. The Web browser client shall support at a minimum, the following functions;
 - 1. User log-in identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
 - 2. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
 - 3. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
 - 4. Storage of the graphical screens shall be in the Network Area Controller (NAC) without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
1.07 SUBMITTALS

- A. Product Data: Provide data for each system component and software module.
- B. Shop Drawings:
 - 1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
 - 2. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations. Provide demonstration diskette containing graphics.
 - 3. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
 - 4. Indicate description and sequence of operation of operating, user, and application software.
- C. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
 - 1. Revise shop drawings to reflect actual installation and operating sequences.
- D. Operation and Maintenance Data:
 - 1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
 - 2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
 - 3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
- E. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner s name and registered with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Delta Controls.
- B. Installing Contractors;
 - 1. Delta Controls Chicago, Inc. Contact Charlie McLauchlan, 630-589-3800
 - 2. Murphy Miller.
 - 3. F.E. Moran.

2.02 SYSTEM DESCRIPTION

- A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units.
- B. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
- C. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.

- D. Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 23 09 13.
- E. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.
- F. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

2.03 OPERATOR INTERFACE

A. Interface new controllerS into existing Campus building automation system.

2.04 CONTROLLERS

- A. BUILDING CONTROLLERS
 - 1. General:
 - a. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
 - b. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - c. Share data between networked controllers.
 - d. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - e. Utilize real-time clock for scheduling.
 - f. Continuously check processor status and memory circuits for abnormal operation.
 - g. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
 - h. Communication with other network devices to be based on assigned protocol.
 - 2. Communication:
 - a. Controller to reside on a BACnet network using ISO 8802-3 (ETHERNET) Data Link/Physical layer protocol.
 - b. Perform routing when connected to a network of custom application and application specific controllers.
 - c. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
 - 3. Anticipated Environmental Ambient Conditions:
 - a. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
 - 4. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.

- 5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
- 6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.

B. CUSTOM APPLICATION CONTROLLERS

- 1. General:
 - a. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - b. Share data between networked, microprocessor based controllers.
 - c. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - d. Utilize real-time clock for scheduling.
 - e. Continuously check processor status and memory circuits for abnormal operation.
 - f. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
 - g. Communication with other network devices to be based on assigned protocol.
- 2. Communication:
 - a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
 - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
- 3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
- 4. Provisions for Serviceability:
 - a. Diagnostic LED's for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
- 5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
- 6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
- C. INPUT/OUTPUT INTERFACE

- 1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.
- 2. All Input/Output Points:
 - a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
 - b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.
- 3. Binary Inputs:
 - a. Allow monitoring of On/Off signals from remote devices.
 - b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
 - c. Sense dry contact closure with power provided only by the controller.
- 4. Pulse Accumulation Input Objects: Conform to all requirements of binary input objects and accept up to 10 pulses per second.
- 5. Analog Inputs:
 - a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
 - b. Compatible with and field configurable to commonly available sensing devices.
- 6. Binary Outputs:
 - a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
 - b. Outputs provided with three position (On/Off/Auto) override switches.
 - c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
- 7. Analog Outputs:
 - a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
 - b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
 - c. Drift to not exceed 0.4 percent of range per year.
- 8. Tri State Outputs:
 - a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.
 - b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:
 - c. Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
- 9. System Object Capacity:
 - a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.
 - b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

2.05 POWER SUPPLIES AND LINE FILTERING

A. Power Supplies:

- 1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
- 2. Limit connected loads to 80 percent of rated capacity.
- 3. Match DC power supply to current output and voltage requirements.
- 4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
- 5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
- 6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
- 7. Operational Ambient Conditions: 32 to 120 degrees F.
- 8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD 810 for shock and vibration.
- 9. Line voltage units UL recognized and CSA approved.
- B. Power Line Filtering:
 - 1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.
 - 2. Minimum surge protection attributes:
 - a. Dielectric strength of 1000 volts minimum.
 - b. Response time of 10 nanoseconds or less.
 - c. Transverse mode noise attenuation of 65 dB or greater.
 - d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

2.06 LOCAL AREA NETWORK (LAN)

- A. Provide communication between control units over local area network (LAN).
- B. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.
- C. LAN Data Speed: Minimum 19.2 Kb.
- D. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.
- E. Transmission Median: Fiber optic or single pair of solid 24 gage twisted, shielded copper cable.
- F. Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.07 CONTROLLER SOFTWARE

- A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.
- B. System Security:
 - 1. User access secured via user passwords and user names.
 - 2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
 - 3. User Log On/Log Off attempts are recorded.

- 4. Automatic Log Off occurs following the last keystroke after a user defined delay time.
- C. Object or Object Group Scheduling:
 - 1. Weekly Schedules Based on Separate, Daily Schedules:
 - a. Include start, stop, optimal stop, and night economizer.
 - b. 10 events maximum per schedule.
 - c. Start/stop times adjustable for each group object.
- D. Provide standard application for equipment coordination and grouping based on function and location to be used for scheduling and other applications.
- E. Alarms:
 - 1. Binary object is set to alarm based on the operator specified state.
 - 2. Analog object to have high/low alarm limits.
 - 3. All alarming is capable of being automatically and manually disabled.
 - 4. Alarm Reporting:
 - a. Operator determines action to be taken for alarm event.
 - b. Alarms to be routed to appropriate workstation.
 - c. Reporting Options:
- F. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.
- G. Sequencing: Application software based upon specified sequences of operation shown on the Drawings.
- H. PID Control Characteristics:
 - 1. Direct or reverse action.
 - 2. Anti-windup.
 - 3. Calculated, time-varying, analog value, positions an output or stages a series of outputs.
 - 4. User selectable controlled variable, set-point, and PED gains.
- I. Staggered Start Application:
 - 1. Prevents all controlled equipment from simultaneously restarting after power outage.
 - 2. Order of equipment startup is user selectable.
- J. On-Off Control with Differential:
 - 1. Algorithm allows binary output to be cycled based on a controlled variable and set-point.
 - 2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.
- K. Run-Time Totalization:
 - 1. Totalize run-times for all binary input objects.
 - 2. Provides operator with capability to assign high run-time alarm.

2.08 HVAC CONTROL PROGRAMS

- A. General:
 - 1. Support Inch-pounds and SI (metric) units of measurement.
 - 2. Identify each HVAC Control system.
- B. Optimal Run Time:

- 1. Control start-up and shutdown times of HVAC equipment for both heating and cooling.
- 2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.
- 3. Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions.
- 4. Use outside air temperature to determine early shut down with ventilation override.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.02 INSTALLATION

- A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
- B. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation.
- C. Provide conduit and electrical wiring in accordance with Section 26 06 20.26. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.
 - 1. Provide conduit for all control wiring exposed to view. This includes but is not limited to all storage rooms, mechanical rooms, and similar spaces.
 - 2. Provide conduit for all control wiring concealed in inaccessible spaces. This includes but is not limited to wiring above/behind drywall and plaster ("hard") ceilings or soffits, and wiring within vertical chase spaces, regardless of whether access doors are provided or not.
 - 3. Control wiring that is concealed above readily accessible ceilings such as acoustical lay-in ceilings, need not be run in conduit.
- D. All exposed conduit wiring that is not located above an accessible ceiling shall be installed in conduit. This includes all storage room, mechanical rooms, etc.

3.03 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate complete and operating system to Owner. END OF SECTION

SECTION 23 21 13 HYDRONIC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hydronic system requirements.
- B. Heating water and glycol piping, above grade.
- C. Equipment drains and overflows.
- D. Pipe hangers and supports.
- E. Unions, flanges, mechanical couplings, and dielectric connections.
- F. Valves:
 - 1. Ball valves.
 - 2. Butterfly valves.
 - 3. Check valves.
- G. Flow controls.

1.02 RELATED REQUIREMENTS

- A. Section 23 05 53 IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT.
- B. Section 23 07 19 HVAC Piping Insulation.
- C. Section 23 21 14 Hydronic Specialties.
- D. Section 23 25 00 HVAC Water Treatment: Pipe cleaning.

1.03 REFERENCE STANDARDS

- A. ASME BPVC-IX Boiler and Pressure Vessel Code, Section IX Welding, Brazing, and Fusing Qualifications; 2015.
- B. ASME B16.3 Malleable Iron Threaded Fittings: Classes 150 and 300; 2011.
- C. ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
- D. ASME B16.22 Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.
- E. ASME B31.9 Building Services Piping; 2014.
- F. ASTM A53/A53M Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- G. ASTM A106/A106M Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service; 2014.
- H. ASTM A234/A234M Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2015.
- I. ASTM A536 Standard Specification for Ductile Iron Castings; 1984 (Reapproved 2014).

- J. ASTM B32 Standard Specification for Solder Metal; 2008 (Reapproved 2014).
- K. ASTM B88 Standard Specification for Seamless Copper Water Tube; 2014.
- L. ASTM B88M Standard Specification for Seamless Copper Water Tube (Metric); 2013.
- M. ASTM D1785 Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2015.
- N. ASTM D2000 Standard Classification System for Rubber Products in Automotive Applications; 2012.
- O. ASTM D2241 Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series); 2015.
- P. ASTM D2466 Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2013.
- Q. ASTM D2467 Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80; 2006.
- R. ASTM D2855 Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings; 1996 (Reapproved 2010).
- S. ASTM F708 Standard Practice for Design and Installation of Rigid Pipe Hangers; 1992 (Reapproved 2008).
- T. ASTM F1476 Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007 (Reapproved 2013).
- U. AWS D1.1/D1.1M Structural Welding Code Steel; 2015.
- V. AWWA C606 Grooved and Shouldered Joints; 2011.
- W. MSS SP-58 Pipe Hangers and Supports Materials, Design, Manufacture, Selection, Application, and Installation; 2009.

1.04 SUBMITTALS

- A. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.
- B. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- C. Project Record Documents: Record actual locations of valves.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with minimum three years of experience.

- C. Provide all grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.
- D. Coupling Manufacturer:
 - 1. Perform on-site training by factory-trained representative to the Contractor's field personnel in the proper use of grooving tools and installation of grooved joint products.
 - 2. Periodic job site visits by factory-trained representative to ensure best practices in grooved joint installation.
 - 3. A distributor's representative is not considered qualified to perform the training.
- E. Welder Qualifications: Certify in accordance with ASME BPVC-IX.
 - 1. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
- B. Piping: Provide piping, fittings, hangers and supports as required, as indicated, and as follows:
 - 1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
 - 2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
 - 3. Grooved mechanical joints may be used in accessible locations only.
 - a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Architect/Engineer.
 - b. Grooved mechanical connections and joints comply with AWWA C606.
 - 1) Ductile Iron: Comply with ASTM A536, Grade 65-45-12.
 - 2) Steel: Comply with ASTM A106/A106M, Grade B or ASTM A53/A53M.
 - c. Use rigid joints unless otherwise indicated.
 - d. Use gaskets of molded synthetic rubber with central cavity, pressure responsive configuration and complying with ASTM D2000, Grade 2CA615A15B44F17Z for circulating medium up to maximum 230 degrees F or Grade M3BA610A15B44Z for circulating medium up to maximum 200 degrees F.
 - 4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.

- C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
 - 1. Where grooved joints are used in piping, provide grooved valve/equipment connections if available; if not available, provide flanged ends and grooved flange adapters.
- D. Valves: Provide valves where indicated:
 - 1. Provide drain valves where indicated, and if not indicated provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch gate valves with cap; pipe to nearest floor drain.
 - 2. Isolate equipment using butterfly valves with lug end flanges or grooved mechanical couplings.
 - 3. For throttling, bypass, or manual flow control services, use ball or butterfly valves.
 - 4. In heating water systems, butterfly valves may be used interchangeably with gate and globe valves.
 - 5. For shut-off and to isolate parts of systems or vertical risers, use ball or butterfly valves.
- E. Welding Materials and Procedures: Conform to ASME BPVC-IX.

2.02 HEATING WATER AND GLYCOL PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
 - 1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
 - 2. Threaded Joints: ASME B16.3, malleable iron fittings.
 - 3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- B. Mechanical Room Only: Steel Pipe; ASTM A-53, roll or cut grooved-ends as appropriate to material, wall thickness, pressures, size and joining method. Pipe ends to be grooved in accordance with current listed standards conforming to ANSI/AWWA C-606.
 - Fittings: Cast ductile iron conforming to ASTM A-536, Grade 65-45-12, forged steel conforming to ASTM A-234, Grade WPB 0.375" wall or fabricated from Std. Wt. carbon steel pipe conforming to ASTM A-53, Type F, E or S, Grade B. Provide fittings with an alkyd enamel finish or hot dip galvanized to ASTM A-153. Zinc electroplated fittings and couplings conform to ASTM B633.
 - Couplings: Rigid type coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1 and B31.9.
 2" through 6", Victaulic Style 107, installation ready rigid coupling for direct stab installation without field disassembly. Steel bolts, nuts and washers.
 - Gasket: Grade "EHP" EPDM compound with red color code designed for operating temperatures from -30 deg F to +250 deg F. Gasket shall conform to steel pipe outside diameter and coupling housing.
- C. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn, using one of the following joint types:
 - 1. Fittings: ASME B16.18, cast brass/bronze or ASME B16.22, wrought copper and bronze.
 - 2. Solder Joints:
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - 3. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.

- 4. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, non toxic synthetic rubber sealing elements. Sealing elements shall be factory installed by fitting manufacturer. Press ends shall have means to indicate non-pressed fitting during pressure test.
 - a. Manufacturers:
 - 1) Viega LLC.
 - 2) Nibco.

2.03 EQUIPMENT DRAINS AND OVERFLOWS

- A. Steel Pipe: ASTM A53/A53M, Schedule 40 galvanized; using one of the following joint types:
 - 1. Threaded Joints: Galvanized cast iron, or ASME B16.3 malleable iron fittings.
 - 2. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- B. PVC Pipe: ASTM D1785, Schedule 40, or ASTM D2241, SDR 21 or 26.
 - 1. Fittings: ASTM D2466 or D2467, PVC.
 - 2. Joints: Solvent welded in accordance with ASTM D2855.

2.04 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
 - 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
- B. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Carbon steel, adjustable swivel, split ring.
- C. Hangers for Cold Pipe Sizes 2 Inches and Greater: Carbon steel, adjustable, clevis.
- D. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
- E. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- F. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
- G. Vertical Support: Steel riser clamp.
- H. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- I. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
- J. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
- K. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.

2.05 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

- A. Unions for Pipe 2 Inches and Less:
 - 1. Ferrous Piping: 150 psig malleable iron, threaded.
 - 2. Copper Pipe: Bronze, soldered joints.

- B. Flanges for Pipe 2 Inches and Greater:
 - 1. Ferrous Piping: 150 psig forged steel, slip-on.
 - 2. Copper Piping: Bronze.
 - 3. Gaskets: 1/16 inch thick preformed neoprene.
- C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
 - 1. Dimensions and Testing: In accordance with AWWA C606.
 - 2. Mechanical Couplings: Comply with ASTM F1476.
 - 3. Housing Material: Ductile iron, galvanized complying with ASTM A536.
 - 4. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
 - 5. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
 - 6. When pipe is field grooved, provide coupling manufacturer's grooving tools.
- D. Dielectric Connections:
 - 1. Waterways:
 - a. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
 - b. Dry insulation barrier able to withstand 600 volt breakdown test.
 - c. Construct of galvanized steel with threaded end connections to match connecting piping.
 - d. Suitable for the required operating pressures and temperatures.
 - 2. Flanges:
 - a. Dielectric flanges with same pressure ratings as standard flanges.
 - b. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
 - c. Dry insulation barrier able to withstand 600 volt breakdown test.
 - d. Construct of galvanized steel with threaded end connections to match connecting piping.
 - e. Suitable for the required operating pressures and temperatures.

2.06 BALL VALVES

- A. Manufacturers:
 - 1. Nibco, Inc; Model S-585-70-66.
 - 2. Watts.
 - 3. Apollo.
- B. Up To and Including 2 Inches:
 - 1. Bronze one piece body, chrome plated brass ball, teflon seats and stuffing box ring, lever handle with balancing stops, solder ends with union.
- C. Over 2 Inches:
 - 1. Ductile iron body, chrome plated stainless steel ball, teflon or Virgin TFE seat and stuffing box seals, lever handle, flanged ends, rated to 800 psi.

2.07 BUTTERFLY VALVES

A. Manufacturers:

- 1. Nibco; Model LD 2000.
- 2. Crane Valve.
- 3. Milwaukee Valve Company.
- B. Body: Ductile iron with resilient molded-in EPDM seat, lug ends, extended neck.
- C. Disc: Construct of aluminum bronze, geometric drive (one piece stem, no pin through disc).
- D. Stem: Stainless steel with stem offset from the centerline to provide full 360 degree circumferential setting.
- E. Operator: 10 position lever handle.

2.08 SWING CHECK VALVES

- A. Manufacturers:
 - 1. Nibco, Inc.
 - 2. Stockham.
 - 3. Grinnell.
 - 4. Jomar.
- B. Up To and Including 2 Inches:
 - 1. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder ends.
 - 2. Nibco Model S-433-Y.
- C. Over 2 Inches:
 - 1. Iron body, bronze trim, bronze faced rotating swing disc, renewable disc and seat, flanged ends.
 - 2. Nibco Model F-918-B.

2.09 SPRING LOADED CHECK VALVES

- A. Manufacturers:
 - 1. Nibco, Inc.
 - 2. Hammond Valve.
 - 3. Milwaukee Valve Company.
- B. Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer or threaded lug ends.

2.10 FLOW CONTROLS

- A. Construction: Class 125, Brass or bronze body with union on inlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
- B. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

- B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.
- C. Remove scale and dirt on inside and outside before assembly.
- D. Prepare piping connections to equipment using jointing system specified.
- E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- F. After completion, fill, clean, and treat systems. Refer to Section 23 25 00 for additional requirements.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Press connections: Copper and copper alloy press connections shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully inserted in the fitting. The joints shall be pressed using the tool(s) approved by the manufacturer.
- C. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
- D. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- E. Install piping to conserve building space and to avoid interfere with use of space.
- F. Group piping whenever practical at common elevations.
- G. Sleeve pipe passing through partitions, walls and floors.
- H. Provide sleeve and watertight mechanical seal on all underground floor and wall penetrations.
- I. Slope piping and arrange to drain at low points.
- J. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- K. Grooved Joints:
 - 1. Install in accordance with the manufacturer's latest published installation instructions.
 - 2. Gaskets to be suitable for the intended service, molded, and produced by the coupling manufacturer.
- L. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
 - 2. Support horizontal piping as scheduled.
 - 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches of each horizontal elbow.
 - 5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.

- 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- M. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 23 07 19.
- N. Use eccentric reducers to maintain top of pipe level.
- O. Install valves with stems upright or horizontal, not inverted.

3.03 SCHEDULES

A. Hanger Spacing for Copper Tubing.

- 1. 1/2 inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
- 2. 1 inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
- 3. 1-1/2 inch and 2 inch: Maximum span, 8 feet; minimum rod size, 3/8 inch.
- 4. 2-1/2 inch: Maximum span, 9 feet; minimum rod size, 3/8 inch.
- 5. 3 inch: Maximum span, 10 feet; minimum rod size, 3/8 inch.
- 6. 4 inch: Maximum span, 12 feet; minimum rod size, 1/2 inch.
- B. Hanger Spacing for Steel Piping.
 - 1. 1/2 inch, 3/4 inch, and 1 inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
 - 2. 1-1/4 inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 3. 1-1/2 inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - 4. 2 inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 - 5. 2-1/2 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
 - 6. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
 - 7. 4 inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
 - 8. 6 inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
 - 9. 8 inches: Maximum span, 19 feet; minimum rod size, 5/8 inch.

END OF SECTION

SECTION 23 21 14 HYDRONIC SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Expansion tanks.
- B. Air vents.
- C. Air separators.
- D. Strainers.
- E. Suction diffusers.
- F. Combination pump discharge valves.
- G. Pressure-temperature test plugs.
- H. Combination flow controls.
- I. Radiator valves.
- J. Pressure reducing valves.

1.02 RELATED REQUIREMENTS

- A. Section 22 10 06 Plumbing Piping Specialties: Backflow preventers.
- B. Section 23 21 13 Hydronic Piping.
- C. Section 23 25 00 HVAC Water Treatment: Pipe cleaning.

1.03 REFERENCE STANDARDS

A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; 2015.

1.04 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model.
- C. Project Record Documents: Record actual locations of flow controls.
- D. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 EXPANSION TANKS

- A. Manufacturers:
 - 1. Amtrol Inc.
 - 2. ITT Bell & Gossett.
 - 3. Taco, Inc.
 - 4. Armstrong Fluid Technology.
- B. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, rated for working pressure of 125 psi, with flexible EPDM diaphragm or bladder sealed into tank, and steel support stand.
- C. Accessories: Pressure gage and air-charging fitting, tank drain; precharge to 12 psi.
- D. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure back flow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

2.02 AIR VENTS

- A. Manufacturers:
 - 1. ITT Bell & Gossett.
 - 2. Taco, Inc.
 - 3. Armstrong Fluid Technology.
- B. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
- C. Float Type:
 - 1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
 - 2. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

2.03 STRAINERS

- A. Manufacturers:
 - 1. ITT Bell & Gossett.
 - 2. Armstrong Fluid Technology.
 - 3. Taco, Inc.
- B. Size 2 inch and Under:
 - 1. Screwed brass or iron body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen.
- C. Size 2-1/2 inch to 4 inch:

- 1. Provide flanged or grooved iron body for 175 psi working pressure, Y pattern with 3/64 inch stainless steel perforated screen.
- D. Size 5 inch and Larger:
 - 1. Provide flanged or grooved iron body for 175 psi working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.04 SUCTION DIFFUSERS

- A. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable 5/32 inch mesh strainer to fit over cylinder strainer, 20 mesh start up screen, and permanent magnet located in flow stream and removable for cleaning.
- B. Accessories: Adjustable foot support, blowdown tapping in bottom, gage tapping in side.

2.05 PUMP CONNECTORS

- A. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.
 - 1. Maximum Allowable Working Pressure: 150 psig at 120 degrees F.
 - 2. Accommodate the Following:
 - a. Angular Rotation: 15 degrees.
 - b. Axial deflection.
 - c. Lateral movement.
 - d. Force developed by 1.5 times specified maximum allowable operating pressure.
 - 3. End Connections: Same as specified for pipe jointing.
 - 4. Provide necessary accessories including, but not limited to, control rods.

2.06 COMBINATION PUMP DISCHARGE VALVES

- A. Manufacturers:
 - 1. ITT Bell & Gossett.
 - 2. Armstrong Fluid Technology.
 - 3. Taco, Inc.
- B. Valves: Straight or angle pattern, flanged cast-iron valve body with bolt-on bonnet for 175 psi operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.

2.07 PRESSURE-TEMPERATURE TEST PLUGS

A. Manufacturers:

- 1. Ferguson Enterprises Inc.
- 2. Peterson Equipment Company Inc.
- 3. Sisco Manufacturing Company Inc.
- B. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F.
- C. Application: Use extended length plugs to clear insulated piping.

2.08 COMBINATION FLOW CONTROLS

- A. Manufacturers:
 - 1. ITT Bell & Gossett.
 - 2. Armstrong Fluid Technology.
 - 3. Taco, Inc.
- B. Construction:
 - 1. Up to 2 inches; Bronze body, bronze trim.
 - 2. Over 2 inches; Ductile iron body, bronze trim.
- C. Control Mechanism: Y-pattern globe valve and digital handwheel with memory stop, inside screw, rubber O-ring disc, solder or screwed ends. Valve shall provide precise flow measurement, precision flow balancing, positive shut-off with no drip seat and drain port for hose bib fitting.

2.09 RADIATOR VALVES

A. Angle or straight pattern, rising stem, inside screw globe valve for 125 psi working pressure, with bronze body and integral union for screwed connections, renewable composition disc, plastic wheel handle for shut-off service, and lockshield key cap and set screw memory bonnet for balancing service.

2.10 PRESSURE REDUCING VALVES

- A. Operation: Automatically feeds make-up water to the hydronic system whenever pressure in the system drops below the pressure setting of the valve. Refer to Section 23 21 13.
- B. Materials of Construction:
 - 1. Valve Body: Constructed of bronze, cast iron, brass, or iron.
 - 2. Internal Components: Construct of stainless steel or brass and composition material.

C. Connections:

- 1. NPT threaded: 0.50 inch, or 0.75 inch.
- 2. Soldered: 0.50 inch.
- D. Provide integral check valve and strainer.
- E. Maximum Inlet Pressure: 100 psi.
- F. Maximum Fluid Temperature: 180 degrees F.
- G. Operating Pressure Range: Between 10 psi and 25 psi.

2.11 MULTI-PORT PRESSURE MANIFOLD

- A. Manufacturers:
 - 1. Flow Conditioning Corp: Trumpet Valve.
 - 2. Hydronic Monitor Co., Inc.
 - 3. Substitutions: See Section 01 60 00 Product Requirements.
- B. One piece manifold of brass construction with ports for connection to hydronic system. Spring return pushbuttons, gauge connection port and test port connection for gauge calibration.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Provide manual air vents at system high points and as indicated.
- C. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- D. Provide valved drain and hose connection on strainer blow down connection.
- E. Provide pump suction fitting on suction side of centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.
- F. Provide combination pump discharge valve on discharge side of centrifugal pumps where indicated.
- G. Support pump fittings with floor mounted pipe and flange supports.
- H. Provide radiator valves on water inlet to terminal heating units such as radiation, unit heaters, and fan coil units.
- I. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.
- J. Multi-port pressure manifold shall be attached to system piping with heavy bracket at height to permit easy pushbutton operation and gauge observation.

END OF SECTION

SECTION 23 21 23 HYDRONIC PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. In-line circulators.
- B. Vertical in-line pumps.

1.02 RELATED REQUIREMENTS

- A. Section 23 21 13 Hydronic Piping.
- B. Section 23 21 14 Hydronic Specialties.
- C. Section 26 27 17 Equipment Wiring.

1.03 REFERENCE STANDARDS

A. UL 778 - Standard for Motor-Operated Water Pumps; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
- C. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 01 60 00 Product Requirements, for additional provisions.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacture, assembly, and field performance of pumps, with minimum three years of documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Armstrong Fluid Technologies.
- B. ITT Bell & Gossett.
- C. Taco, Inc..

2.02 HVAC PUMPS - GENERAL

A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

B. Products Requiring Electrical Connection: Listed and classified by UL or testing agency acceptable to Authority Having Jurisdiction as suitable for the purpose specified and indicated.

2.03 SENSORLESS VARIABLE SPEED VERTICAL IN-LINE PUMPS

- A. Manufacturers;
 - 1. Bell & Gossett; Model Series e-80SC with Integrated Technologic Control.
 - 2. Armstrong Fluid Technology.; Model 4300 IVS.
 - 3. Taco; Model SKS.
- B. The pumps shall be a split-coupled, inline for vertical installation, in cast iron stainless steel fitted construction specifically designed for quiet operation. Suitable standard operations at 250° F and 175 PSIG working pressure. Working pressures shall not be de-rated at temperatures up to 250°F. The pump internals shall be capable of being serviced without disturbing piping connections.
- C. The pumps shall have a solid steel shaft that is guided by a carbon graphite lower throttle bushing.
- D. Pump shall be equipped with a Unitized inside mechanical seal assembly with flush line. The seal assembly shall have an EPR elastomer bellows and a positive metal-to-metal drive system to reduce torsional stress on the bellows. The bellows will be pressure supported without creases or folds for long life. The mechanical seal shall have a rotating carbon face against a stationary ceramic face.
- E. Pump shaft shall connect to a stainless steel impeller. Impeller shall be hydraulically and dynamically balanced to Hydraulic Institute Standards ANSI/HI 9.6.4.5-2000. The allowable residual imbalance conforms to ANSI grade 6.3, keyed to the shaft and secured by a stainless steel locking capscrew or nut.
- F. The pump shall include a spacer coupling of high tensile aluminum, split to allow the servicing of the mechanical seal without disturbing the pump or motor. Coupling shall incorporate tapered washer shaft jacking design.
- G. The combination motor bracket and volute coverplate shall be a one-piece unit to ensure concentric alignment of the motor to the pump casing. A carbon steel coupler guard conforming to both ANSI B15.1-2000 and OSHA 1910.219 standards shall be mounted on the motor bracket for safety.
- H. Pump volute shall be of a Class 30 cast iron design for heating systems rated for 175 PSIG with integral cast iron flanges drilled for 125# ANSI companion flanges. Volute shall include gauge ports at nozzles, and vent and drain ports. The volute shall be designed with a base ring matching an ANSI 125# flange that can be used for pump support.
- I. Motors shall be NEMA Premium efficient and shall be the size, voltage, and enclosure called for on the plans. Motors shall have heavy-duty grease lubricated ball bearings, completely adequate for the maximum load for which the pump is designed.
- J. Pumps shall conform to ANSI/HI 9.6.3.1 standard for Preferred Operating Region (POR) unless otherwise approved by the engineer.
- K. Pump shall be of a maintainable design and for ease of maintenance should use machine fit parts and not press fit components.

- L. Pump manufacturer shall be ISO-9001 certified.
- M. Each pump shall be factory tested and name-plated before shipment.
- N. As an option, the pump may include an internal stainless steel casing wear rings.
- O. Where noted on schedule pumping equipment may require one or all of the following optional tests: Certified Lab tests (unwitnessed), Hydraulic Institute Level B tests, or Witnessed Tests.
- P. Integrated CFD with Sensorless Pump Control
 - 1. Integrated Pump Controller shall be factory mounted, wired, with a mains disconnect switch and menu-driven graphical interface.
 - 2. Integrated Pump Controller shall provide near unity displacement power factor (cos Ø) without need for external power factor correction capacitors at all loads and speeds using VVC-PWM type integrated controls.
 - 3. Integrated Pump Controller shall include dual DC link reactors equivalent to 5% impedance line reactors, for reduction of mains borne harmonic currents and DC link ripple current to increase DC link capacitor lifetime.
 - 4. Integrated Pump Controller shall have EMI/RFI filters conforming to DIN EN61800-3 to ensure integrated controls meets low emission and immunity requirements.
 - 5. Integrated Pump Controller orientation shall be specified as [VL1], [VL2], [VL3], [VL4]
 - 6. Integrated Pump Controller shall support direct communication with the building management system (BMS) with built-in support for the following protocols: Modbus RTU, [BACnet[™] MS/TP, or Metasys N2.
 - 7. Integrated Pump Controller shall be provided in an Enclosure rated to UL Type 12 suitable for indoor operation.
 - 8. Integrated Pump Controller shall support Programmable skip Frequencies and adjustable switching frequency for noise and vibration control.
 - 9. Integrated Pump Controller shall provide a temperature controlled Fan for cooling of the heat sink in the back panel.
 - 10. Integrated Pump Controller shall be rated to operate in ambient working conditions of 14°F to +113°F, up to 3300 feet above sea level.
 - 11. Integrated Pump Controller shall provide 2 Analog inputs (current or voltage) and 1 current output.
 - 12. Integrated Pump Controller shall provide 6 programmable Digital inputs with 2 configurable as outputs.
 - 13. Integrated Pump Controller shall support 2 programmable pulse inputs
 - 14. Integrated Pump Controller shall provide 2 programmable relay outputs
 - 15. Integrated Pump Controller shall provide 1 RS485 communication port
 - 16. Integrated Pump Controller system software shall be capable of sensorless control in variable volume systems without need for pump mounted (internal/external) or remotely mounted differential pressure sensor.
 - 17. Integrated Pump Controller Sensorless control shall operate under Quadratic Pressure Control (QPC) to ensure head reduction with reducing flow conforms to quadratic control curve.
 - 18. Integrated Pump Controller shall support a minimum head of 40% of design duty head.
 - 19. Integrated Pump Controller shall provide user adjustable control mode settings and minimum/maximum head set points using built-in programming interface.

- 20. Integrated Pump Controller integrated control software shall be capable of controlling pump performance for non-overloading power at every point of operation.
- 21. Integrated Pump Controller integrated control software shall be capable of maintaining flow rate data.

2.04 IN-LINE CIRCULATORS

- A. Manufacturers;
 - 1. Bell & Gossett; Model Series e-80.
 - 2. Armstrong Fluid Technology.
 - 3. Taco.
- B. The pumps shall be close-coupled, inline for vertical or horizontal installation, in cast iron stainless steel fitted construction specifically designed for quiet operation. Suitable standard operations at 225°F and 175 PSIG working pressure. Working pressures shall not be de-rated at temperatures up to 250°F. The pump internals shall be capable of being serviced without disturbing piping connections.
- C. Seal: Buna/Carbon/Ceramic/SS seal (225° F maximum operating temperature).
- D. The pumps shall have a solid alloy steel shaft that is integral to the motor. A non-ferrous shaft sleeve shall be employed to completely cover the wetted area under the seal.
- E. The motor bearings shall support the shaft via heavy-duty grease lubricated ball bearings.
- F. Pump shall be equipped with an internally flushed mechanical seal assembly installed in an enlarged tapered seal chamber. Seal assembly shall have a stainless steel housing, Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.
- G. Pump shaft shall connect to a stainless steel impeller. Impeller shall be hydraulically and dynamically balanced to Hydraulic Institute Standards ANSI/HI 9.6.4.5-2000. The allowable residual imbalance conforms to ANSI grade 6.3, keyed to the shaft and secured by a stainless steel locking capscrew or nut.
- H. Pump should be designed to allow for true back pull-out access to the pump's working components for ease of maintenance.
- Pump volute shall be of a Class 30 cast iron design for heating systems rated for 175 PSIG with integral cast iron flanges drilled for 125# ANSI companion flanges (Optional 250 and 300 PSIG working pressures are available and are 250# flange drilled). Volute shall include gauge ports at nozzles, and vent and drain ports. The volute shall be designed with a base ring matching an ANSI 125# flange that can be used for pump support.
- J. Motors shall meet scheduled horsepower, speed, voltage, and enclosure design. Motors shall have heavy-duty grease lubricated ball bearings to offset the additional bearing loads associated with the closed-coupled pump design. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications.
- K. Pumps shall conform to ANSI/HI 9.6.3.1 standard for Preferred Operating Region (POR) unless otherwise approved by the engineer.

- L. Pump shall be of a maintainable design and for ease of maintenance should use machine fit parts and not press fit components.
- M. Pump manufacturer shall be ISO-9001 certified.
- N. Each pump shall be factory tested and name-plated before shipment.
- O. Pump may include an internal stainless steel casing wear rings.

2.05 IN-LINE CIRCULATOR (ECM MOTOR)

- A. The pumps shall be a wet rotor inline pump, in cast iron or lead free bronze body construction specifically designed for quiet operation. Suitable standard operations at 230° F and 175 PSIG working pressure. The pump internals shall be capable of being serviced without disturbing piping connections.
- B. The pump internals shall be capable of being serviced without disturbing piping connections.
- C. Pump shall be equipped with a water-tight seal to prevent leakage.
- D. Pump volute shall be of a cast iron design for heating systems or lead free bronze for domestic water systems. The connection style on the cast iron and bronze pumps shall be flanged.
- E. Flange to Flange dimension shall be standard Bell & Gossett booster sizes such as 6-3/8", 8-1/2", 11-1/2", and 12". Flange dimensions shall be HVAC industry standard 2 or 4 bolts sizes.
- F. Motor shall be a synchronous, permanent-magnet (PM) motor and tested with the pump as one unit. Conventional induction motors will not be acceptable.
- G. Each motor shall have an Integrated Variable Frequency Drive tested as one unit by the manufacturer.
- H. Integrated motor protection shall be verified by UL to protect the pump against over/under voltage, over temperature of motor and/or electronics, over current, locked rotor and dry run (no load condition).
- I. Pump shall have MODBUS or BACnet connections built into the VFD as standard options.
- J. Analog inputs, such as 0-10V and 4-20mA, are standard inputs built into the VFD.
- K. Pumps shall be UL 778 listed and bear the UL Listed Mark for USA and Canada with on-board thermal overload protection.
- L. Pumps shall be UL 778 listed and bear the UL Listing Mark for USA and Canada with on-board thermal overload protection.
- M. Each pump shall be factory performance tested before shipment.
- N. Operating Modes;
 - 1. Proportional Pressure The differential pressure will continuously increase or decrease along a linear curve based on the flow demand.
 - 2. Constant Pressure The pump maintains a constant differential pressure set by the user at any flow demand until the maximum speed is reached.
 - 3. Constant Speed The pump maintains a constant speed at any flow rate

- 4. Night Set Back The pump will recognize a 10°C water temperature reduction and will switch to nighttime operation.
- 5. T-Constant This control will use a PI algorithm to vary the speed of the pump in order to maintain a constant temperature of the fluid media.
- 6. Delta-T Constant This control mode will use a PI algorithm to vary the speed of the pump in order to maintain a constant differential temperature between the built-in temperature sensor and external temperature sensor.
- 7. Delta-P-T This control mode is paired with proportional or constant pressure mode. The nominal differential pressure setpoint will vary according to the fluid temperature.
- 8. Delta-P-Delta-T This control mode is paired with proportional or constant pressure mode. The nominal differential pressure setpoint will vary according to the differential temperature between the built-in temperature sensor and external temperature sensor.

PART 3 EXECUTION

3.01 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.
- C. Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.
- D. Lubricate pumps before start-up.
- E. Provide side-stream filtration system for closed loop systems. Install across pump with flow from pump discharge to pump suction from pump tappings.

END OF SECTION

SECTION 23 25 00 HVAC WATER TREATMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Materials.
 - 1. System cleaner.
 - 2. Closed system treatment (water).
- B. By-pass (pot) feeder.
- C. Side-stream filtration equipment.

1.02 RELATED REQUIREMENTS

- A. Section 23 21 13 Hydronic Piping.
- B. Section 23 21 14 Hydronic Specialties.

1.03 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Indicate placement of equipment in systems, piping configuration, and connection requirements.
- D. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.

1.04 REGULATORY REQUIREMENTS

- A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems and to public sewage systems.
- B. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. IWM; Owner's campus service provider. Contract with IWM for all cleaning and chemical requirements. Larry McCarthy, 847-875-7190.

2.02 MATERIALS

- A. System Cleaner:
 - 1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodiumtripoly phosphate and sodium molybdate.
- B. Closed System Treatment (Water):

- 1. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
- 2. Corrosion inhibitors; boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
- 3. Conductivity enhancers; phosphates or phosphonates.

2.03 BY-PASS (POT) FEEDER

- A. Manufacturers:
 - 1. Griswold Controls.
 - 2. J. L. Wingert Company.
 - 3. Neptune, a brand of the Dover Company.
- B. 6.0 gal quick opening cap for working pressure of 175 psi.

2.04 SIDE-STREAM FILTRATION SYSTEM

- A. System: Flow indicator, filter housing with cartridge filter, shut-off valves, and flow control valve.
- B. Hot Water Filter Housing: Glass reinforced nylon plastic suitable for 220 degrees F and 200 psi operating conditions.
- C. Cartridges: 30 micron for start-up and 10 micron for system operation.

PART 3 EXECUTION

3.01 PREPARATION

- A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
- B. Place terminal control valves in open position during cleaning.
- C. Verify that electric power is available and of the correct characteristics.

3.02 CLEANING SEQUENCE

- A. Concentration:
 - 1. As recommended by manufacturer.
 - 2. Fill steam boilers only with cleaner and water.
- B. Hot Water Heating Systems:
 - 1. Apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum.
 - 2. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water.
 - 3. Circulate for 6 hours at design temperatures, then drain.
 - 4. Refill with clean water and repeat until system cleaner is removed.
- C. Use neutralizer agents on recommendation of system cleaner supplier and approval of Architect/Engineer.
- D. Flush open systems and glycol filled closed systems with clean water for one hour minimum. Drain completely and refill.

- E. Remove, clean, and replace strainer screens.
- F. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.04 CLOSED SYSTEM TREATMENT

- A. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.
- B. Introduce closed system treatment through bypass feeder when required or indicated by test.
- C. Provide 3/4 inch water coupon rack around circulating pumps with space for 4 test specimens. END OF SECTION

SECTION 23 52 16 CONDENSING BOILERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Boiler construction.
- B. Boiler trim.
- C. Fuel burning system.
- D. Factory installed controls.

1.02 RELATED REQUIREMENTS

- A. Section 23 21 14 Hydronic Specialties.
- B. Section 23 21 23 Hydronic Pumps.
- C. Section 23 25 00 HVAC Water Treatment.
- D. Section 26 27 17 Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. AHRI Directory of Certified Product Performance Air-Conditioning, Heating, and Refrigeration Institute (AHRI); current edition at www.ahrinet.org.
- B. ASHRAE Std 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings; 2013, Including All Addenda.
- C. ASME BPVC-IV Boiler and Pressure Vessel Code, Section IV Rules for Construction of Heating Boilers; 2015.
- D. HI BTS-2000 Testing Standard, Method to Determine Heating Efficiency of Commercial Space Heating Boilers; 2007.
- E. NFPA 54 National Fuel Gas Code; 2015.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittals procedures.
- B. Product Data: Provide data indicating general assembly, components, controls, safety controls, and wiring diagrams with electrical characteristics and connection requirements, and service connections.
- C. Manufacturer's Installation Instructions: Indicate assembly, support details, connection requirements, and include start up instructions.

- D. Manufacturer's Field Reports: Burner manifold gas pressure, percent carbon monoxide (CO), percent oxygen (O), percent excess air, flue gas temperature at outlet, ambient temperature, net stack temperature, percent stack loss, percent combustion efficiency, and heat output.
- E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.
- F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of condensing hydronic boilers with welded steel pressure vessels.
- B. The boiler shall have an ASME Section IV pressure vessel rated for a maximum allowable working pressure of 160 PSIG and a maximum allowable working temperature of 210°F.
- C. The entire boiler system and its installation shall conform to the manufacturer's instructions, applicable codes and associated National Board requirements.
- D. The equipment shall be in strict compliance with the requirements of this specification and shall be the manufacturer's standard commercial product unless specified otherwise. Additional equipment features, details, accessories, etc. which are not specifically identified but which are a part of the manufacturer's standard commercial product, shall be included in the equipment being furnished.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect boilers from damage by leaving factory inspection openings and shipping packaging in place until final installation.

1.08 WARRANTY

- A. See Section 01 78 00 Closeout Submittals, for additional warranty requirements.
- B. Provide a ten (10) year limited warranty to include coverage for heat exchanger, pressure vessel and condensation collection basin against defects in materials or workmanship and failure due to thermal shock.

PART 2 PRODUCTS

2.01 CONDENSING BOILERS

- A. Manufacturers;
 - 1. Fulton; Model Endura EDR.
 - 2. Lochinvar; Model Crest FBN.
- B. Construction
 - 1. Description: Factory-fabricated, -assembled, and -pressure tested, duplex stainless steel firetube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including flue gas vent; combustion air intake connections, water supply, water return, condensate drain, and controls. The boiler, burner and controls shall be completely factory

assembled as a self-contained unit. Each boiler shall be neatly finished, thoroughly tested, and properly packaged for shipping. Closed-loop water heating service only.

- 2. Heat Exchanger: The heat exchanger is defined as the surfaces of the pressure vessel where flue gases transfer sensible and latent heat to the hydronic fluid. The heat exchanger shall be a three-pass firetube design constructed using only duplex alloys of stainless steel.
 - a. The boiler shall be a firetube design, such that all combustion chamber components are within water-backed areas. Watertube boilers will not be accepted.
 - b. Furnace: First pass of the combustion chamber shall be constructed of duplex alloy stainless steel with a minimum wall thickness of 0.25" and a minimum bottom head thickness of 0.625".
 - c. Firetubes: Second and third passes of the combustion chamber shall be constructed of duplex alloys of stainless steel having a minimum wall thickness of [EDR-1500/2000: 0.109"].
 - d. Furnace to tube connections shall be constructed with low weld intensity, a tube to tube minimum spacing of 2" center to center, minimum 5/8" tube to tube ligament, and shall not contain any overlapping welds.
 - e. Heat exchange capability shall be maximized within the heat exchanger via the use of corrugated firetube technology. The corrugation process shall not remove any material from the tubes. Aluminum heat transfer enhancements are dissimilar metals and are unacceptable.
 - f. Material: The heat exchanger shall have the following material characteristics and properties:
 - 1) The metallic crystalline lattice microstructure shall contain approximately equal amounts of body center cubic (BCC) and face centered cubic (FCC) structures to offer high resistance to intergranular corrosion.
 - 2) A minimum Pitting Resistance Equivalent Number (PREN) of 26.
 - 3) A minimum Yield Strength of 65 ksi at 0.2% plastic strain.
 - 4) A minimum Ultimate Tensile Strength of 94 ksi.
 - 5) To minimize stresses caused by uneven expansion and contraction, the Coefficient of Thermal Expansion at 212°F shall not be less than 7.0 in/in °F 10-6 and shall not be greater than 7.5 in/in °F 10-6.
 - 6) To increase resistance to pitting and crevice corrosion, the Chromium content shall not be less than 21% by mass.
 - 7) For high mechanical strength, the Nitrogen content shall not be less than 0.17% by mass.
 - 8) Boilers with heat exchangers constructed of austenitic stainless steels, such as 316L or 304, and ferritic stainless steels, such as 439, are unacceptable.
 - 9) Boilers with heat exchangers constructed of cast aluminum, mild steel, cast iron or copper finned tube materials are unacceptable.
- 3. Pressure Vessel: Design and construction shall be in accordance with Section IV of the ASME Code for heating boilers.
 - a. The shell shall be minimum [EDR-1500/2000: 0.3125"] thick steel, SA-790 or SA-516 Grade 70.
 - b. The top head shall be a minimum 0.375" thick steel, SA-790 or SA-516 Grade 70.

- c. The water side of the pressure vessel shall be a counter-flow design with internal water-baffling plates.
- d. The boiler return and supply water connections shall be [EDR-1500/2000: 4" 150# ANSI flanged]. The water connections shall not be designed to support an external structural load from the piping system.
- e. The maximum water pressure drop across the boiler inlet and outlet connections, shall not exceed [EDR-1500: 0.9 PSID at 150 GPM] [EDR-2000: 1.6 PSID at 200 GPM].
- 4. Burner: Standard natural gas, forced draft.
 - a. Burner Head: Shall be a woven fiber premix design.
 - b. Excess Air: The burner shall operate at no greater than 7.0% excess O2 over the entire turndown range. Due to significant reductions in combustion efficiency at high levels of excess O2, boilers exceeding 7.0% excess O2 at any operating condition shall not be accepted.
 - c. Emissions: When operating on natural gas, the boiler shall maintain a NOx level of <20 ppm, and CO emissions less than 50 ppm, over the complete combustion range at a 3% O2 correction.
- 5. Blower: Variable speed, non sparking, hardened aluminum impeller centrifugal fan to operate during each burner firing sequence and to pre-purge and post-purge the combustion chamber.
 - a. Motor: Brushless DC variable speed motor with hall effect sensor feedback; internal electronic commutation controller with built in speed control and protection features; long life, sealed, ball bearing with high temperature grease.
 - b. Variable speed blower: PWM signal input with tachometer output.
- 6. Main Fuel Train:
 - a. The boiler shall have a pre-mix combustion system, capable of operating at a minimum 4" W.C. incoming natural gas pressure while simultaneously achieving emissions performance, full modulation, and full rated input capacity. Maximum natural gas pressure allowed to the inlet of the fuel train shall be no less than 28" W.C.
 - b. A factory mounted main fuel train shall be supplied. The fuel train shall be fully assembled complete with high and low gas pressure switches, wired, and installed on the boiler and shall comply with CSD-1 code. The fuel train components shall be enclosed within the boiler cabinet.
 - c. A lock up regulator upstream of the fuel train shall be furnished by the boiler manufacturer as a standard component integral to the boiler cabinet. Factory test fire of the boiler with the provided lock up regulator is required.
 - d. Standard CSD-1 fuel train shall comply with IRI, which has been replaced by XL GAPS.
- Ignition: Direct spark ignition with transformer. Pilot assemblies are not accepted. A UV scanner shall be utilized to ensure precise communication of flame status back to the flame programmer. Flame rods are not accepted.
- 8. Boiler Enclosure:
 - a. Sealed Cabinet: Jacketed steel enclosure with left hinged full height front access door, fully removable latching access panels, gasketed seams to maintain sealed combustion, mounted on a steel skid with steel plate decking.
 - b. Control Enclosure: NEMA 250, Type 1.
 - c. Finish: Internally and externally primed and painted finish.
 - d. Combustion Air: Drawn from the inside of the sealed cabinet, preheating the combustion air.

- 9. Rigging and Placement: The boiler shall come with lifting eyes and fork hole accessibility for rigging.
- 10. Exhaust Manifold: Shall be constructed of stainless steel, with an area for the collection and disposal of flue gas condensate. The exhaust outlet connection shall allow for immediate vertical rise off the boiler without requiring an elbow or tee.
- 11. Characteristics and Capacities:
 - a. Heating Medium: Closed loop hot water with up to 50% propylene or ethylene glycol by volume. Standard capacities shall be based on 100% water.
 - b. Design Water Pressure Rating: 160 psig.
 - c. Minimum Return Water Temperature: No minimum temperature required.
 - d. Maximum Allowable Water Temperature: 210°F.
 - e. Minimum Water Flow Rate: No minimum flow rate required to protect the heat exchanger.
 - f. Maximum Water Flow Rate: No maximum flow rate requirement.
 - g. Minimum Delta-T: No minimum delta-T required.
 - h. Maximum Delta-T: 100°F
 - i. Minimum Side Clearance: Shall not exceed 1" between any number of boilers.
 - j. Jacket Losses: External convection and radiation heat losses to the boiler room from the boiler shall comply with IAW ASHRAE 103-2007, and shall not exceed 0.2% of the rated boiler input at maximum capacity.
- 12. The boiler shall have its efficiency witnessed and certified by an independent third party, and the efficiency must be listed on the AHRI directory (www.ahridirectory.org) for natural gas operation. The test parameters for efficiency certification shall be the BTS-2000 standard. The certified thermal efficiency for natural gas firing shall not be less than [EDR-1500: 93.5%] [EDR-2000: 93.7%].
- 13. A zero flow or low flow condition shall not cause any harm to the pressure vessel or heat exchanger of the boiler. Flow switches, dedicated circulator pumps, or primary-secondary arrangements shall not be required to protect the boiler from thermal shock. Boilers requiring the use of flow switches or primary-secondary piping arrangements are unacceptable.
- C. Trim
 - 1. Safety Relief Valve: ASME Rated.
 - 2. Pressure and Temperature Gauge: Minimum 3-1/2" diameter, combination pressure and -temperature gauge. Gauges shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
 - a. Mounted in the field in the boiler supply water piping prior to the first isolation valve by the boiler installer.
 - 3. Combustion Air Inlet Filter: 50 Micron.
 - 4. Flue Gas Condensate Drain Trap: A flue gas condensate drain trap shall be provided to prevent positive pressure exhaust gases from entering the boiler room.
 - 5. Flue Gas Condensate Neutralization: pH neutralization accommodations available upon request.
- D. Controls
 - 1. The boiler electrical control panel shall include the following devices and features:
 - a. 7" color touch screen control display factory mounted on the front cabinet panel door.

- The control display shall serve as a user interface for programming parameters, boiler control and monitoring; and shall feature a screen saver, screen disable for cleaning, contrast control, volume control for alarm features, boiler status, configuration, history and diagnostics.
- b. The boiler control panel shall be constructed in a UL 508 approved panel shop.
- c. 24 VAC control transformer.
- d. Control relay for 120 VAC motorized isolation valve control.
- e. The flame safeguard control on the boiler shall be integrated with temperature control and lead/lag sequencing modular boiler plant functionality.
- f. All controls are to be cabinet, vessel or panel mounted and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls. All controls shall be mounted and wired according to UL requirements.
- 2. Burner Operating Controls: To maintain safe operating conditions, factory mounted and wired burner safety controls limit burner operation:
 - a. High Limit: A single UL 353 temperature probe shall function as a dual-element outlet temperature sensor and shall comply with CSD-1 CW-400 requirements for 2 independent temperature control devices.
 - 1) High limit sensor shall be NTC resistive 10KOhm +/- 1% at 77°F. Sensor shall have brass material bulb with 1.181 +/- 0.015" insertion and 0.370 +/- 0.005" bulb diameter.
 - 2) Manual reset stops burner if operating conditions rise above maximum boiler design temperature.
 - b. Low-Water Cut Off: Electronic probe type mounted in the pressure vessel shall prevent burner operation on low water alarm.
 - c. Air Safety Switch: Prevent operation unless sufficient combustion air is proven.
 - d. High Condensate Probe: Prevent operation in the event of a blocked condensate drain.
 - e. Blocked Exhaust: Prevent operation in the event of a blocked flue gas exhaust stack.
- 3. Boiler Operating Controls and Features:
 - a. Proportional Integral Derivative (PID) temperature load control capability for up to two loops, central heat and domestic hot water.
 - b. Operating temperature limit for automatic start and stop.
 - c. Flue gas exhaust temperature monitoring.
 - d. Return water temperature monitoring.
 - e. Time of day display.
 - f. Customizable boiler name display.
 - g. Alarm history for 15 most recent alarms including equipment status at time of lockout.
 - h. Password protection options.
 - i. Indirect domestic hot water priority.
 - j. Outdoor air temperature (OAT) reset controls with warm weather shutdown:
 - 1) OAT reset shall automatically adjust the setpoint according to changes in the outdoor temperature.
 - 2) The boiler manufacturer shall provide an OAT sensor and module.
 - 3) The sensor shall have +/- 1.5°F accuracy at 70°F, field installed in an outdoor area not exposed to direct sunlight or the exhaust of other mechanical equipment, and field wired to the master boiler.
 - 4) The control shall be field programmed with the outdoor reset schedule.
- 5) The control shall have the ability to disable the entire hydronic boiler system on warm weather shutdown based on a programmable OAT.
- 4. Sequencing Control of Modular Boiler Plants: Sequencing capabilities (lead/lag) shall be integral to the boiler controller for up to 8 boilers installed in the same hydronic loop and shall not require an external panel.
 - a. The boiler manufacturer shall provide a supply water header temperature sensor.
 - 1) The sensor shall be NTC resistive 10KOhm +/- 1% at 77°F, field installed in the common supply water piping, and field wired to the master boiler.
 - b. One (1) boiler in the system shall be field programmed as the master and subsequent boilers will be programmed as lag units.
 - c. Sequence of Operation:
 - 1) Upon call for heat and demand in the system, a boiler will be enabled at low fire and will modulate according to demand and PID settings up to the base load common value. The base load common shall be field adjustable with a default setting of 40%.
 - 2) If the heating load exceeds the output at the base load common firing rate, the next boiler in the sequence will be enabled at low fire. Modular boilers will modulate up and down in parallel as a cohesive unit with infinite modulation points to meet heating load requirements.
 - 3) This process continues until all available boilers are enabled, at which point they are released to modulate up to full fire if required.
 - 4) As the load decreases, the boilers will be sequentially disabled.
 - 5) Boiler sequence order shall be rotated on a programmable number of run hours.
 - 6) A boiler in lockout alarm shall be automatically removed from the sequence order.
 - 7) Lag boilers shall default to local control if the master boiler is fully powered off or removed.
 - 8) Each individual boiler shall enable and disable a water circulation control device. The enable of the device, for example a motorized isolation valve or boiler circulator, will be simultaneous with the heat demand for that boiler. The disable of each device will be based on a programmable time delay when the heat demand is no longer present. In variable primary arrangements, the control shall hold the lead boiler isolation valve open at all times.
- 5. Building Automation System Interface: Hardware and software to enable building automation system (BAS) to monitor, control, and display boiler status and alarms.
 - a. Hardwired Contacts:
 - 1) Monitoring: Boiler Status, Burner Demand, General Alarm, Firing Rate.
 - 2) Control with Factory Installed Jumper: Safety Interlock for External Device, Remote Boiler Enable, Remote Lead/Lag Enable, Emergency Stop (E-Stop)
 - 3) Remote Setpoint Signal: 4-20 mA.
 - b. Communication Protocol: A communication interface with BAS shall enable BAS operator to remotely enable and monitor the boiler plant from an operator workstation.
 - 1) The boilers will communicate with each other and the Building Automation System via a daisy chain addressed Modbus network. Field wiring between nodes shall be twisted pair low voltage with shielded ground.
- E. A BACnet MSTP and IP protocol communication gateway shall be provided. The BACnet gateway is field installed on the MASTER boiler. Lag boilers shall not require a dedicated BACnet gateway

for the BAS to monitor status. The BAS shall only be required to communicate through the MASTER boiler. A communication point mapping list shall be provided.

- F. Condensate Neutralization Kit: Factory supplied condensate trap with condensate trip sensor, high capacity condensate receiver prefilled with appropriate medium.
- G. Electrical Power;
 - 1. Single-Point Field Power Connection: Factory-installed and factory-wired switches, transformers, control and safety devices and other devices shall provide a single-point field power connection to the boiler.
 - 2. Electrical Characteristics:
 - a. Voltage: 120 V.
 - b. Phase: Single.
 - c. Frequency: 60 Hz.
- H. Venting
 - 1. The boiler shall be capable of operating with a stack effect not exceeding -0.04" W.C. and a combined air intake and exhaust venting pressure drop not exceeding +1.50" W.C.
 - 2. Combustion Air Intake: It shall be acceptable to either direct vent the boiler using sealed combustion by drawing combustion air in from the outdoors or by drawing air from the mechanical space itself.
 - a. Sealed Combustion: Schedule 40 PVC pipe or smooth-walled galvanized steel, vent termination with 1/2" x 1/2" mesh bird screen.
 - b. Mechanical Space: Adequate combustion air and ventilation shall be supplied to the boiler room in accordance with local codes.
 - 3. Flue Gas Exhaust: The flue gas exhaust stack shall be AL 29-4C or 316L stainless steel, listed and labeled to UL-1738 / C-UL S636 for use with Category II/IV appliances, guaranteed appropriate for the application by the manufacturer and supplier of the venting.
 - 4. The boiler shall be capable of common exhaust and intake venting. The draft system shall be designed to prevent the backflow of exhaust gases through idle boilers.
 - 5. Condensate drain piping must be galvanized, stainless steel, or Schedule 40 CPVC. Copper, carbon steel, or PVC pipe materials are not accepted.

2.02 CONDENSING BOILERS

- A. Manufacturers;
 - 1. Fulton; Model Endura EDR+.
 - 2. Lochinvar; Model Crest FBN.
- B. Construction
 - Description: Factory-fabricated, -assembled, and -pressure tested, duplex stainless steel firetube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including flue gas vent; combustion air intake connections, water supply, water return, condensate drain, and controls. The boiler, burner and controls shall be completely factory assembled as a self-contained unit. Each boiler shall be neatly finished, thoroughly tested, and properly packaged for shipping. Closed-loop water heating service only.
 - 2. Heat Exchanger: The heat exchanger is defined as the surfaces of the pressure vessel where combustion gases transfer heat to the hydronic fluid.

- a. The boiler shall be a single-pass firetube design, such that all combustion chamber components are within water-backed areas. Watertube boilers will not be accepted.
- b. Furnace to tube connections shall be constructed with low weld intensity, a tube to tube minimum spacing of 2 tube diameters center to center, minimum 1 tube diameter tube to tube ligament, and shall not contain any overlapping welds.
- c. Heat transfer capability shall be maximized via the use of corrugated firetubes. The corrugation process shall not remove any material from the tubes. Finned, twisted tape, or coil type tube inserts negatively impact ease of maintenance and will not be accepted.
- d. The boiler shall compensate for heat exchanger thermal expansion using a stress relief deflection element external to the pressure vessel shell. The deflection element shall act to protect the boiler tubes and tubesheets from exposure to longitudinal thermal expansion stresses. The deflection element shall not be in contact with flue gases.
 - 1) Designs using the tubes, tubesheets, or furnace components to compensate for thermal expansion require cutting, welding, tube repair, or complete heat exchanger replacement in the event of deflection element failure and are not accepted.
 - 2) Designs which do not compensate for thermal expansion stresses are not accepted.
- e. Tubesheet to tube weld stresses while the boiler is in operation shall never exceed 1.0 ksi.
- f. Material: The heat exchanger furnace, tubesheets, and firetubes shall be constructed of duplex alloy stainless steel. Austenitic stainless steels, such as 316L or 304, and ferritic stainless steels, such as 439, are not accepted.
 - For long term durability, heat exchanger material of construction must have a minimum Ultimate Tensile Strength of 101 ksi, and a minimum 0.2% Yield Strength of 77 ksi. Weaker materials of construction with reduced strength are not accepted. Boilers seeking an approval must provide documentation that supports this requirement or will be rejected.
 - 2) Heat exchangers constructed of cast aluminum, mild steel, cast iron or copper finned tube materials are not accepted.
- 3. Exhaust manifold shall be minimum 0.5" thick stainless steel, ASME designation SA-351 CF3M, and shall be a water-backed design to enhance heat transfer. Dry-back style flue gas condensate collection pan exhaust manifolds are not accepted.
- 4. Pressure Vessel: Design and construction shall be in accordance with Section IV of the ASME Code for heating boilers.
 - a. The shell shall be minimum 0.375" thick steel, SA-53B ERW.
 - b. The top head shall be a minimum 0.50" thick steel, SA-790 or SA-516 Grade 70.
 - c. The pressure vessel shall be a counter-flow design with internal water-baffling plates.
 - d. The boiler return and supply water connections shall be 150# ANSI flanged. The water connections shall not be designed to support an external structural load from the piping system.
 - e. The water volume of the boiler shall not be less than 80 gallons.
 - f. The maximum water pressure drop across the boiler inlet and outlet connections shall not exceed [3.0 PSID at 235 GPM for 2,500 MBTU/hr boiler] [5.0 PSID at 289 GPM for 3,000 MBTU/hr boiler] [5.8 PSID at 570 GPM for 6,000 MBTU/hr boiler].
- 5. Fuel/Air Mixture Combustion System: Air and gas pre-mix on the suction side of the fan.
 - a. Closed-loop oxygen sensor feedback shall automatically adjust the fuel/air ratio. O2 monitoring-only systems that cannot adjust for operation variability shall not be accepted.

- b. Combustion air flow shall be controlled by fan speed and a servo-motor actuated butterfly valve. Fuel flow shall be controlled by a servo-motor actuated butterfly valve. Zero governor or negative regulation systems offer less precision and are not capable of independent air and gas control, and are not accepted.
- 6. Burner: Standard natural gas, forced draft, woven fiber mesh design.
 - a. Turndown: Shall be no less than [EDR+2500: 12:1] [EDR+3000: 15:1].
 - b. Excess Air: The burner shall operate at no greater than 8.0% excess O2 over the entire modulation range to maximize seasonal combustion and thermal efficiencies.
 - c. NOx Emissions: When operating on natural gas, the burner shall maintain a level of <20 ppm over the complete combustion range at a 3% O2 correction.
- 7. Blower: Variable speed centrifugal fan to operate during each burner firing sequence and to pre-purge and post-purge the combustion chamber.
 - a. Motor: Totally enclosed fan-cooled premium efficiency AC motor, Class H insulation, variable speed capable with sealed bearings.
 - b. Variable speed drive: IP20 housing, 0-400Hz frequency output capability, overload capacity of 150% for 60 seconds and 200% for 3 seconds, shall fully modulate fan speed according to burner input requirements
- 8. Main Fuel Train:
 - a. A factory mounted fuel train shall be supplied. The fuel train shall be fully assembled and enclosed within the boiler cabinet, complete with factory mounted and wired high and low gas pressure switches in compliance with CSD-1.
- 9. Ignition: Direct spark ignition with transformer. A UV scanner shall be utilized to ensure precise communication of flame status back to the flame programmer. Flame rods are not accepted.
- 10.Boiler Enclosure:
 - a. Cabinet: Jacketed steel enclosure with left hinged full height front access door, fully removable latching access panels, mounted on a steel skid with steel plate decking.
 - b. Control Enclosure: NEMA 250, Type 1.
 - c. Finish: Cabinet shall be powder coated, pressure vessel assembly shall be painted.
 - d. Combustion Air: Factory mounted air filter directly coupled to the blower inlet.
- 11. Rigging and Placement: The boiler shall include lifting eyes and fork hole accessibility for rigging.
- 12. Characteristics and Capacities:
 - a. Standard capacities shall be based on 100% water.
 - b. Minimum Design Water Pressure Rating: 160 psig.
 - c. Minimum Return Water Temperature: No minimum temperature requirements.
 - d. Maximum Allowable Water Temperature (ASME): 210°F.
 - e. Minimum Water Flow Rate: [EDR+2500/3000: 25 gpm].
 - f. Maximum Delta-T: 100°F
 - g. Maximum Allowable Operating Setpoint: 200°F
 - h. Jacket Losses: External convection and radiation heat losses to the boiler room from the boiler shall comply with IAW ASHRAE 103-2007, and shall not exceed 0.2% of the rated boiler input at maximum capacity.
- 13. Flow switches, dedicated circulator pumps, or primary-secondary arrangements shall not be required to protect the boiler from thermal shock. Boilers requiring the use of flow switches or primary-secondary piping arrangements will not be accepted.

14. The equipment shall be in strict compliance with the requirements of this specification and shall be the manufacturer's standard commercial product unless specified otherwise. Additional equipment features, details, accessories, etc. which are not specifically identified but which are a part of the manufacturer's standard commercial product, shall be included in the equipment being furnished.

C. Trim

- 1. Pressure and Temperature Gauge: Minimum 3-1/2" diameter, combination pressure and temperature gauge.
- 2. Flue Gas Condensate Drain Trap: A flue gas condensate drain trap shall be provided to prevent positive pressure exhaust gases from entering the boiler room.
- 3. Flue Gas Condensate Neutralization: pH neutralization shall be provided.

D. Controls

- 1. The boiler electrical control panel shall include the following devices and features:
 - a. 7" color touch screen control display factory mounted on the front cabinet panel door.
 - 1) The control display shall serve as a user interface for programming parameters, boiler control and monitoring; and shall feature a screen saver, boiler status, configuration, history and diagnostics.
 - b. Controls Transformers: 120VAC, 24 VDC, 12 VDC.
 - c. Flame safeguard control with 9 combustion fuel/air load profile points.
 - d. All standard controls shall be factory mounted and wired according to UL requirements.
- 2. Burner Operating Controls: To maintain safe operating conditions, factory mounted and wired burner safety controls limit burner operation:
 - a. O2 Compensation: Closed loop O2 trim shall be provided.
 - b. High Limit: A manual reset mechanical Aquastat device shall stop the burner if operating conditions rise above maximum boiler design temperature.
 - c. Low-Water Cut Off: Electronic probe type mounted in the pressure vessel shall prevent burner operation on low water alarm.
 - d. Air Safety Switch: Prevent operation unless sufficient combustion air is proven.
 - e. Blocked Exhaust: Prevent operation in the event of a blocked flue gas exhaust stack.
- 3. Boiler Operating Controls and Features:
 - a. Inlet Water Temperature Monitoring.
 - b. Combustion Air Temperature Monitoring.
 - c. Flue Gas Exhaust Temperature Monitoring: Sensor probe shall be stainless steel.
 - d. Proportional Integral Derivative (PID) temperature load control capability for hydronic and domestic hot water in standalone or lead/lag operation.
 - e. Operating temperature sensor for automatic start and stop.
 - 1) The temperature sensor shall have tolerance according to IEC 60751
 - f. Time of day display.
 - g. Customizable boiler name display.
 - h. Two customizable boiler interlock terminals displayed.
 - i. Alarm history for a minimum 100 most recent alarms including status at time of lockout.
 - j. Administrative password protection options.
 - k. Indirect domestic hot water priority.
 - I. Outdoor air temperature (OAT) reset controls with warm weather shutdown:

- 1) OAT reset shall automatically adjust the setpoint according to changes in the outdoor temperature, and disable the boilers above a warm weather shutdown temperature.
- 2) The boiler manufacturer shall provide an OAT sensor.
- 3) The temperature sensor shall be field installed in an outdoor area not exposed to direct sunlight or the exhaust of other mechanical equipment, and wired the boiler controller.
 4) The control shall be field programmed with the outdoor reset schedule.
- 4) The control shall be field programmed with the outdoor reset schedule.
- 4. Lead/Lag Control of Modular (Multiple) Boiler Plants: Lead/Lag capabilities shall be integral to the boiler controller for up to 10 boilers installed in the same hydronic loop and shall not require an external panel.
 - a. The boiler manufacturer shall provide a supply water header temperature sensor.
 - 1) The temperature sensor shall have tolerance according to IEC 60751, field installed in the common supply water piping.
 - b. Lead/lag operation shall not require a master boiler or external control panel. Field wired sensors or communication may be connected to any boiler in the lead/lag sequence.
 - c. The boilers shall communicate with each other via a private Ethernet/IP addressed network.
 - 1) Field wiring between boilers shall be shielded Cat5e or Cat6 Ethernet cable.
 - 2) In the event a communication cable becomes damaged or interrupted, communication shall be lost with only one boiler and not the entire lead/lag operation. Daisy chain style wiring lacks this redundancy and shall not be accepted.
 - d. Sequence of Operation:
 - 1) Upon loop temperature dropping below start point, the lead boiler shall be enabled at low fire and shall modulate according to the heating demand.
 - 2) As lag boiler stages are enabled according to heating demand, burners shall return to low fire. Boilers shall modulate in parallel as a cohesive unit according to heating demand.
 - 3) When all boilers are active they shall be released to modulate in parallel up to full fire according to the heating demand.
 - 4) As heating demand decreases, the sequence shall operate in reverse.
 - 5) Rotation of the lead and subsequent lag boilers shall be automatic.
- 5. Building Automation System Interface: Hardware and software to enable building automation system (BAS) to monitor, control, and display boiler status and alarms.
 - a. Hardwired Contacts:
 - 1) Monitoring: Boiler Status, Burner Demand, General Alarm.
 - 2) Control with Factory Installed Jumper: Safety Interlock for External Device, Remote Enable, Emergency Stop (E-Stop).
 - 3) Remote Setpoint Signal: 4-20 mA or 0-10 VDC.
 - b. Communication Protocol: A Modbus communication interface with BAS shall enable BAS operator to remotely enable and monitor the boiler plant from an operator workstation.
 - A BACnet MSTP and IP protocol communication gateway shall be provided. The BACnet gateway is field installed on a boiler. Additional boilers in the lead/lag system shall not require a dedicated BACnet gateway for the BAS to monitor status. A communication point mapping list shall be provided.
 - 2) A LonWorks protocol communication gateway shall be provided. The LonWorks gateway is field installed on a boiler. Additional boilers in the lead/lag system shall not require a

dedicated LonWorks gateway for the BAS to monitor status. A communication point mapping list shall be provided.

- E. Electrical power
 - 1. Single-Point Field Power Connection: Factory-installed and factory-wired switches, transformers, control and safety devices and other devices shall provide a single-point field power connection to the boiler.
 - 2. Electrical Characteristics:
 - a. Voltage: 460 V.
 - b. Phase: Three.
 - c. Frequency: 60 Hz.
- F. Venting
 - The boiler shall be capable of operating with a stack effect not exceeding -0.10" W.C. and a combined air intake and exhaust venting pressure drop not exceeding [EDR+2500/3000: +1.50" W.C.].
 - 2. Combustion Air Intake: It shall be acceptable to either direct vent the boiler using sealed combustion by drawing combustion air in from the outdoors or by drawing air from the mechanical space itself.
 - a. Sealed Combustion: Schedule 40 PVC pipe or smooth-walled galvanized steel, vent termination with 1/2" x 1/2" mesh bird screen.
 - b. Mechanical Space: Adequate combustion air and ventilation shall be supplied to the boiler room in accordance with boiler manufacturer requirements and local codes.
 - 3. Flue Gas Exhaust: The flue gas exhaust stack shall be AL 29-4C or 316L stainless steel, listed and labeled to UL-1738 / C-UL S636 for use with Category II/IV appliances, guaranteed appropriate for the application by the manufacturer and supplier of the venting.
 - 4. Common Exhaust Vents: The draft system shall be designed to prevent the backflow of exhaust gases through idle boilers. The common boiler vent shall not be combined with any other appliance.
 - 5. Condensate drain piping must be galvanized, stainless steel, or Schedule 40 CPVC. Copper, carbon steel, or PVC pipe materials are not accepted.

2.03 CONDENSING BOILERS

- A. Manufacturers
 - 1. Fulton Heating Solutions, Inc.; Model Vantage.
 - 2. Lochinvar; Model Crest.
- B. Boiler Construction
 - 1. The boiler shall be completely factory assembled as a self-contained unit. Each boiler shall be neatly finished, thoroughly tested, and properly packaged for shipping.
 - 2. The pressure vessel design and construction shall be in accordance with Section IV of the ASME Code for heating boilers. The boiler shall comply with CSD-1 code requirements.
 - 3. The firetube area of the heat exchanger where the flue gases will condense shall be constructed using duplex alloys of stainless steel. Austenitic stainless steels of the 300 series, such as 316L or 304, have a relatively high coefficient of linear expansion and thus are unacceptable. Ferritic stainless steels of the 400 series, such as 439, have a relatively low

ultimate tensile strength and a relatively low pitting resistance equivalent number and thus are unacceptable.

- 4. The pressure vessel shell and furnace chamber shall be a minimum 3/8" thick steel, SA-53B ERW pipe or SA-516 Grade 70 plate. A dished head attached to the furnace chamber shall be SA-516 Grade 70 plate. Exhaust pipes attached to the furnace chamber shall be minimum 3" diameter Schedule 40 steel.
- 5. Boilers with heat exchangers using cast aluminum, cast iron or copper finned tube design platforms are unacceptable.
- 6. The pressure vessel shall be fully insulated with high temperature insulation.
- 7. The boiler shall be a fire tube design. The furnace location shall be such that all furnace components are within water-backed areas.
- The water pressure drop across the boiler inlet and outlet connections, shall not exceed:
 a. VTG-5000 5.9 PSID at 500 GPM
- C. Boiler Design
 - 1. External convection and radiation heat losses to the boiler room from the boiler shall be less than 0.5% of the rated boiler input.
 - The boiler shall have its efficiency witnessed and certified by an independent third party, and the efficiency must be listed on the AHRI directory (www.ahridirectory.org) for natural gas operation. The test parameters for efficiency certification shall be the BTS-2000 standard, with 80°F return water temperature, 180°F supply water temperature, steady state operation at full input firing capacity. The certified thermal efficiency for natural gas firing shall not be less than:
 a. VTG-5000 - 92.0%
 - 3. The boiler shall have no minimum return water temperature requirements.
 - 4. The boiler shall have no minimum return water temperature when firing on natural gas or propane.
 - 5. A zero flow or low flow condition shall not cause any harm to the pressure vessel or heat exchanger of the boiler. Flow switches, dedicated circulator pumps, or primary/secondary piping arrangements are not required to protect the heat exchanger or pressure vessel from thermal shock or other system related considerations. Boilers requiring the use of flow switches or primary/secondary piping arrangements are unacceptable.
 - 6. It shall be acceptable to vent the boiler using sealed combustion (drawing in fresh air from the outdoors) or to draw air from the mechanical room itself.
 - a. The flue (exhaust) stack must be AL 29-4C or equivalent material UL-1738/C-UL S636 approved for Category IV condensing, positive pressure applications.
 - b. The air intake piping shall be Schedule 40 PVC or equivalent.
 - c. The boiler shall be capable of operating with an exhaust draft not exceeding -0.04" W.C. and a combined air intake and exhaust venting pressure drop not exceeding +0.35" W.C.
 - 7. Boilers requiring an intake or exhaust muffler for noise sensitive applications are unacceptable.
- D. Controls
 - 1. The boiler control panel shall be constructed in a UL 508A approved panel shop.
 - 2. The flame safeguard control shall be capable of linkage-less modulation and shall provide the following:
 - a. The control shall provide a 30-second pre-purge and post-purge time.

- b. The control shall maintain a running history of operating hours, number of cycles, and the most recent six control lockouts.
- c. The control is connected to a display module, which is capable of retrieving the information listed above.
- 3. The boiler shall be set up for a maximum 5:1 turndown when firing on natural gas.
- 4. Airflow shall be controlled by a butterfly valve connected to a precision servo-motor. Fuel flow shall be controlled by a butterfly valve for gas operation.
- 5. Burner selection:
 - a. The burner shall be a Maxon Ovenpak model nozzle mixing style burner. The burner shall be of industrial grade cast iron design and designed to operate reliably over a variety of operating conditions, including extreme variations of combustion air temperature and pressure.
- 6. The burner shall feature direct spark ignition.
- 7. Boiler safety controls shall include:
 - a. Operating Temperature Controller for automatic start and stop.
 - b. High Limit Temperature Controller with manual reset.
 - c. One Low Water Cutoff Probe in the boiler shell.
 - d. Air Safety Switch to prevent operation unless sufficient combustion air is assured.
 - e. Flame detector to prove combustion.
- 8. All controls are to be burner or panel mounted and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls. All controls shall be mounted and wired according to UL requirements. Electrical power supplied shall be 208/230/460/3/60. A control circuit transformer shall be factory supplied, wired and mounted.
- 9. Boiler sequencing system
 - a. Manufacturers;
 - 1) Synex Controls: Model ModSync.
 - b. The boiler sequencing system will be a microprocessor based process controller with a graphical user interface and touchscreen capabilities. Boiler sequencing systems designed with alpha-numeric displays will not be acceptable due to their limited functionality.
 - c. The active touchscreen display area will be a minimum of 5.7" with a color TFT display resolution of 256 colors.
 - d. The boiler sequencing system enclosure will be NEMA 4X construction. The enclosure shall be designed with the ability of be located in outdoor environments. Mounting of the boiler sequencing system inside another panel to provide an outdoor rating will not be acceptable due to the increased access time requirements to view and modify the system parameters. Power requirements for the boiler sequencing panel will be 120/60/1.
 - e. The boiler sequencing system will be a wall mounted, stand-alone unit. Local boiler controls with integrated lead/lag logic are not acceptable due to their limited logic capabilities and rewiring requirements in the event of a sensor or local controller error.
 - f. Password requirements will prevent access to any of the screens where system configuration parameters can be adjusted, while maintaining the ability of viewing the system performance.
 - g. Outdoor and Supply Header Temperature sensors supplied with the boiler sequencing system shall be PT-100 RTD type for precise temperature monitoring. Return Temperature monitoring capabilities shall be available and used when BTU calculation is used. The

boiler sequencing system will also have the ability to receive temperature values from the Building Management System through a communication protocol. Each temperature input shall have a selection button that allows for independent configuration of where the temperature value will be received from.

- h. The boiler sequencing system will provide a series of "Question and Answer" screens to simplify the commissioning process.
- i. Multiple Status and Configuration Screens will be available for easy interpretation of the hydronic loop status and simplified control configuration of the multiple hydronic boiler system.
- j. Minimum screens available shall include:
 - 1) Outdoor Reset Configuration
 - a) Setback Schedule
 - b) Lead/Lag Configuration
 - c) Boiler Configuration
 - d) System Status
 - e) Alarm Status
 - f) Alarm History
- k. The hydronic boilers shall be controlled as follows to maximize their operating efficiency:
 - The sequencing system shall monitor the outdoor temperature and calculate a hydronic loop temperature set point based on touchscreen selectable user-defined values. The boiler sequencing system will stage operation of the hydronic boilers based on the difference between the actual hydronic loop temperature and the calculated
 - a) Outdoor air reset hydronic loop temperature set point.
 - b) When a requirement for heat is determined by the boiler sequencing system, the lead boiler is energized and its firing rate is maintained at low fire.
 - c) If the hydronic loop temperature continues to decrease, the boiler sequencing system will enable a lag boiler. The first lag boiler is energized and the lag boiler's firing rate is maintained at low fire.
 - d) As additional heat is required, the boiler sequencing system will enable the remaining lag boiler stages individually until all of the available boilers in the hydronic loop have been energized. Each boiler will remain at low fire until all of the stages have been enabled.
 - e) If all of the hydronic boilers are enabled and additional heat is required, the boiler sequencing system will release the boilers to modulate. Operating hydronic boilers at lower firing rate levels provides significant efficiency gains. Therefore, hydronic boilers will modulate together as a single unit to keep the hydronic boiler system at the lowest possible firing rate, while satisfying the building load demands.
 - f) As the hydronic loop temperature increases, the boiler sequencing system will decrease the firing rate of the hydronic boilers to maintain the hydronic loop temperature. If all of the hydronic boilers are at low fire and the hydronic loop temperature continues to rise, the boiler sequencing system will begin to stage the boilers off. The first lag boiler stage energized will be the last stage to be disabled. The hydronic boilers will continue to be disabled by the boiler sequencing system based on the temperature rise of the hydronic loop.

- g) The lead boiler is disabled when the hydronic loop temperature reaches a selectable value referenced around the hydronic loop set point.
- I. Outdoor Reset As the outdoor temperature increases, the hydronic loop set point can decrease while still maintaining the desired building temperature.
 - 1) The boiler sequencing system shall provide Outdoor Reset Configuration Screens that include all of the parameters required to effectively configure the hydronic loop set point based on the outdoor temperature.
 - a) The boiler sequencing system will provide an adjustable reset schedule based on the outdoor temperature. A linear outdoor reset ratio will be determined based on user-defined hydronic loop temperatures at 50°F and 0°F outdoor temperatures. Outdoor temperature configuration variables shall be adjustable through the touchscreen to match designed reset schedule requirements. A reference graphic detailing the calculated reset ratio will be displayed on the Outdoor Reset Configuration screen.
 - b) Minimum and maximum loop temperature parameters will prevent the outdoor reset schedule from operating outside of a user-defined temperature range.
 - c) A user-defined Outdoor Temperature Disable parameter will be provided to disable the hydronic loop if a predetermined outdoor temperature is reached. A hysteresis variable will prevent the hydronic system from re-enabling until the outdoor temperature decreases a user-defined amount.
 - d) To meet multiple system control configurations, set point mode adjustment capabilities will be included as standard with the boiler sequencing system. set point Modes will include Outdoor Reset, 4-20mA Remote set point, BMS Communication or Manual. The set point mode shall be field adjustable by a touchscreen selection button on the set point Configuration screen.
- m. Setback Configuration Screens shall be provided to adjust the hydronic loop set point based on Day of the Week/Time of Day variables.
 - Multiple setback schedules shall be available based on whether the building is in Occupied or Unoccupied mode. Building Mode selection shall be determined by a user-defined Time of Day / Day of Week touchscreen entry. The Building Mode will automatically change between Occupied and Unoccupied based on the user programmed day and times. Manual Building Mode control shall also be available via a Setup menu. Building Mode shall be indicated on the Loop Status Screen for ease of reference.
 - a) An Anticipation Mode feature shall be provided to automatically switch to Occupied Mode a selectable number of hours earlier than scheduled if the outdoor temperature lowers below a user-defined temperature during the Unoccupied Mode.
- n. Lead/Lag Configuration screens shall be used to configure how the hydronic boilers will be assigned and enabled in the control sequence.
 - 1) The boiler sequencing system will include automatic rotation of the lead boiler based on a user configured lead boiler cycle count or run hours, whichever setting occurs first.
 - a) When the lead cycle or run hours rotation value is reached, the boiler sequencing system will assign each boiler's position in the lead/lag sequence based on their previous operating history. Boiler sequencing systems that simply rotate the lead position to the next boiler in the sequence will not be acceptable due to their

ineffective ability of maintaining an even cycle count across all of the boiler stages in the hydronic loop.

- b) The boiler sequencing system will stage the boilers based on a PID generated control variable value. The Proportional, Integral and Derivative values shall be user-defined through the Lead/Lag Configuration screen. Each lag boiler stage will be enabled and disabled based on a user-defined control variable percentage. Properly tuned loops will provide temperature control accuracy up to +/- 2°F, based on load demand.
 - (1) Lead boiler start and stop parameters shall be user-defined through the touchscreen operator interface. A Manual Reset parameter will allow the Proportional Band to be shifted around set point.
- c) A user-defined time delay parameter will be provided that delays enabling and disabling of the lag boiler stages. This helps to decrease cycling of the lag stages when the building load is close to being satisfied.
- d) The boiler sequencing system will have the ability to monitor the outlet temperature of each hydronic boiler in the system. This feature is beneficial for systems that will incorporate variable flow designs. If the boiler outlet temperature exceeds set point by a user-defined amount, the boiler sequencing system will automatically lower the firing rate of the boiler to help prevent a high limit trip at the boiler. As the boiler outlet temperature decreases below a defined variable, the boiler sequencing system will allow the firing rate of the boiler to increase.
- o. Boiler Configuration screens will display information regarding each boiler stage in the hydronic loop.
 - 1) The boiler configuration screens will detail and provide:
 - a) Hydronic Boiler Status.
 - b) Hydronic Boiler Cycles, Run Hours and Cycle/Hour Ratio calculation.
 - c) Hydronic Boiler Outlet Temperature.
 - d) Hydronic Boiler Enable/Disable touchscreen selection.
 - e) Hydronic Boiler Auto/Manual touchscreen control mode selection.
 - f) Hydronic Boiler Manual touchscreen Start/Stop and Firing Rate control.
 - g) The boiler sequencing system shall include capabilities to enable/disable the boilers through the operator interface. Boilers that are disabled will not be included in the sequencing logic.
- p. The boiler sequencing system will monitor the operation and status of all temperature sensors and hydronic boilers in the loop. Sensor errors will be annunciated on the boiler sequencing systems alarm screen. If an outdoor temperature sensor error occurs, the boiler sequencing system will automatically switch to manual set point mode and will annunciate the alarm condition.
- q. The boiler sequencing system will start a timer when each boiler stage is enabled to run. If the main gas valves do not energize within the user-defined timeframe then a local limit is preventing the boiler from operating. The boiler sequencing system will immediately remove the boiler from the lead/lag sequence and annunciate that a local boiler error exists. An automatic reset option will allow the boiler to be re-enabled after a user-defined timeframe has elapsed.
- r. An Alarm Status screen will give a text description of any current alarm conditions. Boiler sequencing systems that use codes or symbols to detail alarm conditions will not be

acceptable. The boiler sequencing system will automatically adjust the boiler sequencing status and remove the boiler from the sequencing logic if an alarm occurs. The boiler will automatically be added back into the rotation loop as soon as the boiler sequencing system senses that the alarm has been cleared.

- s. The boiler sequencing panel will include an Alarm History screen that allows for the
- t. last 100 alarm conditions to be viewed. A Date/Time stamp and text description of each alarm condition in the history will be available.
- u. A System Status screen will detail current outdoor, hydronic system and control variable values. The status screen will also display enable/disable and firing rate information for each of the boilers in the hydronic loop.
- v. Trending of the supply temperature, system set point and outdoor temperature will be displayed to provide system operational history for tuning of the PID and lead/lag parameters.
- w. The boiler sequencing system will have the ability to communicate to a Building Management System using multiple protocols including Modbus RTU, BacNet, LonWorks or N2. Standard point mapping will be provided with the boiler sequencing system. Selection of modbus serial connectivity (RS-232/RS-485) and baud rate will be field-adjustable using a configuration screen on the boiler sequencing system. Selection of BacNet MS/TP or IP shall be field adjustable through a dip-switch setting. The ability to field adjust custom project points will be available through a easy to configure and freely distributed software package.
- x. The boiler sequencing system shall have the ability for the internal control logic to be field-modified to meet system design changes that may arise during commissioning of the hydronic system or future system expansion. The control logic shall be field adjustable through a downloadable, freely distributed software package that does not require a licensing fee. Sequencing systems with fixed control logic that cannot be modified in the field will not be acceptable due to their inherent limitations.
- 10. When multiple boilers are to be installed in a common hydronic loop, boiler sequencing system shall be provided. The sequencing system shall monitor, enable, disable and control the firing rate of each boiler in the loop to maximize the boiler operating efficiency.
 - a. Manufacturers:
 - 1) Synex Controls; Model ModSync.
 - b. Sequencing system shall be be a factory prewired panel. Panel shall have digital display that indicates time, day, boiler water temperature based on outside air temperature, water temperature set-back programming and failure diagnostics.
 - c. Panel features shall include;
 - 1) Outdoor reset.
 - 2) Setback scheduling.
 - 3) Multiple setpoint modes.
 - 4) Trending data.
 - 5) Alarm status and history.
 - 6) Mobile alerts.
 - 7) Interface card for communication with building automation system. Protocols shall include BACnet, Modbus or Lonworks.
 - d. Panel shall have a 5.7" color touchscreen for user interface.

- E. Main Fuel Train Components
 - 1. A factory mounted main gas train shall be supplied. The gas train shall be fully assembled, wired, and installed on the boiler and shall comply with CSD-1 code. Compliance with other codes is available upon request. The maximum pressure rating of the components shall not be less than one psi. The gas train shall consist of at least two manual shutoff valves, one gas pressure regulator, one automatic safety shutoff valve with prove of closure, one flow control valve, one high gas pressure switch, and one low gas pressure switch. The automatic safety shutoff valve and flow control valve may be the same valve. A pilot gas train, when supplied, shall comply with the same code and maximum gas pressure rating as the main gas train.
 - Standard CSD-1 fuel trains shall comply with IRI, which has been replaced by GE GAP. Normally open vent valves are no longer required between the safety shut off valves. NFPA 85 compliance shall be available from the factory to comply with local codes or regulations that specifically require a vent valve.
- F. Boiler Fittings and Trim
 - 1. The boiler shall be supplied with an ASME Section IV safety relief valve. The safety relief valve size shall be in accordance with ASME code requirements.
 - 2. The boiler shall be supplied with a temperature/pressure gauge to be mounted on the water outlet piping of the boiler.
 - 3. A condensate drain connection shall be provided in the exhaust outlet. A condensate neutralizing drain kit will be provided to collect and drain the flue gas condensate.
 - 4. The water supply and return connections on the boiler shall be 150# flanged connections, 6" diameter. The water connections shall not be designed to support any external structural load from the piping system.
 - 5. The boiler shall come with lifting eyes and fork truck holes accessible for rigging.
 - 6. Instructions for installation, operation and maintenance of the boiler shall be contained in a manual provided with each boiler.
 - 7. A wiring diagram corresponding to the boiler configuration shall be included with each boiler.
 - 8. A factory test fire report corresponding to the boiler configuration shall be included with each boiler.
- G. Venting
 - 1. Vent system shall be an insulated positive stack pressure system and Category IV vent material in accordance to ANSI Standard (AGA) and CGA standards. Boiler venting shall be provided through stainless steel Grade AL 29-4C and shall be able to handle positive pressure and flue gas condensate.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
 - 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in of piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 BOILER INSTALLATION

- A. Install equipment on 4" concrete housekeeping pad.
- B. Install gas-fired boilers according to NFPA 54.
- C. Assemble and install boiler trim.
- D. Install electrical devices furnished with boiler but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.

3.03 CONNECTIONS

- A. Install boilers level on concrete bases. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.
- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of equipment connection. Provide a reducer if required.
- E. Connect hot-water piping to supply and return boiler tappings with shutoff valve and union or flange at each connection.
- F. Install piping from safety relief valves to nearest floor drain.
- G. Boiler Venting:
 - 1. Install flue venting kit and combustion-air intake.
 - 2. Connect full size to boiler connections.
- H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.04 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Perform installation and startup checks according to manufacturer's written instructions. Complete startup form included with Boiler and return to Manufacturer as described in the instructions.

- 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
- 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
- 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.05 DEMONSTRATION

- A. Engage a factory representative or a factory-authorized service representative for boiler startup. Start-up sheet shall be completed and a copy shall be sent to the Engineer and the Manufacturer. A combustion analysis shall be completed and the gas valve adjusted per the Installation and Operations manual and note in start-up report.
- B. Factory representative or a factory-authorized representative shall provide Owners training to instruct maintenance personnel to adjust, operate, and maintain boilers. END OF SECTION

SECTION 23 55 33 FUEL-FIRED UNIT HEATERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Gas fired unit heaters.

1.02 RELATED REQUIREMENTS

A. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. ASHRAE Std 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings; 2013, Including All Addenda.
- B. ASHRAE Std 103 Methods of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers; 2007, Including All Amendments.
- C. NFPA 54 National Fuel Gas Code; 2015.
- D. NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.
- E. NFPA 211 Guide for Smoke and Heat Venting; 2013, Including All Amendments.
- F. UL 103 Factory-Built Chimneys for Residential Type and Building Heating Appliances; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's literature and data indicating rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listing.

PART 2 PRODUCTS

2.01 GAS FIRED UNIT HEATERS

- A. Manufacturers:
 - 1. Modine Manufacturing Company.
 - 2. Sterling HVAC/Mestek Technology, Inc.
 - 3. Reznor/Thomas & Betts Corporation.
- B. Unit Heaters: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heat exchanger, burner, controls, and accessories:
 - 1. Heating: Natural gas fired.
 - 2. Discharge Louvers: Individually adjustable horizontal and vertical louvers to match cabinet finish.
 - 3. Downturn Nozzle: 30 degree nozzle to match outlet and cabinet finish.

- C. Cabinet: Galvanized steel with baked enamel finish, easily removed and secured access doors, glass fiber insulation and reflective liner.
- D. Supply Fan: Propeller type with direct drive.
- E. Heat Exchanger: Aluminized steel welded construction.
- F. Gas Burner:
 - 1. Atmospheric type with adjustable combustion air supply,
 - 2. Gas valve modulating capable of 50% to 100 %, provides 100 percent safety gas shut-off; 24 volt combining pressure regulation, safety pilot, manual set (On-Off), pilot filtration, automatic electric valve.
 - 3. Electronic pilot ignition, with electric spark igniter.
- G. Gas Burner Safety Controls:
 - 1. Thermocouple sensor: Prevents opening of gas valve until pilot flame is proven and stops gas flow on ignition failure.
 - 2. Vent safety shutoff sensor: Temperature sensor installed on draft hood and prevents operation, manual reset.
- H. Operating Controls
 - 1. Room Thermostat: Cycles burner to maintain room temperature setting.
- I. Performance:
 - 1. Ratings: Energy Efficiency Rating (EER)/Coefficient of Performance (COP) not less than requirements of ASHRAE Std 90.1; seasonal efficiency to ASHRAE Std 103.
- J. Accessories:
 - 1. Unit mounted convenience outlet.
 - 2. Disconnect switch UL listed.
 - 3. Motor starter.

2.02 DOUBLE WALL METAL STACKS

- A. Provide double wall metal stacks, tested to UL 103 and UL listed with positive pressure rating, for use with building heating equipment, in compliance with NFPA 211.
- B. Fabricate with 1 inch minimum air space between walls and construct inner liner of 304 stainless steel and outer jacket of aluminized steel.
 - 1. Protect aluminized steel surfaces exposed to the elements with a minimum of one base coat of primer and one finish coat of corrosion resistant paint suitable for outer jacket skin temperatures of the application.
- C. Accessories, UL labeled:
 - 1. Ventilated Roof Thimble: Consists of roof penetration, vent flashing with spacers and storm collar.
 - 2. Stack Cap: Consists of conical rainshield with inverted cone for partial rain protection with low flow resistance.

2.03 ROOM THERMOSTATS

A. Room Thermostat: Adjustable, low voltage, to control burner operation, and supply fan to maintain temperature setting.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that space is ready for installation of units and openings are as indicated on shop drawings.
- B. Verify that proper power supply is available.
- C. Verify that proper fuel supply is available for connection.

3.02 INSTALLATION

- A. Install in accordance with NFPA 90A.
- B. Install gas fired units in accordance with NFPA 54 and applicable codes.
- C. Provide vent connections in accordance with NFPA 211. END OF SECTION

SECTION 23 82 00 CONVECTION HEATING AND COOLING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Unit heaters.

1.02 RELATED REQUIREMENTS

- A. Section 23 09 93 Sequence of Operations for HVAC Controls.
- B. Section 23 21 13 Hydronic Piping.
- C. Section 26 27 17 Equipment Wiring: Electrical characteristics and wiring connections. Installation of room thermostats. Electrical supply to units.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS

- A. Manufacturer's Instructions: Indicate installation instructions and recommendations.
- B. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access or valving.
- C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 HYDRONIC UNIT HEATERS

- A. Manufacturers:
 - 1. Modine Manufacturing Company.
 - 2. Sterling Hydronics, a Mestek Company.
 - 3. Daikin.
- B. Coils: Seamless copper tubing, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.
- C. Perform factory run test under normal operating conditions, water, and steam flow rates.
- D. Casing: Minimum 18 gage, 0.0478 inch thick sheet steel casing with threaded pipe connections for hanger rods for horizontal models and minimum 18 gage, 0.0478 inch thick sheet steel top and bottom plates for vertical projection models.

- E. Finish: Factory applied baked enamel of color.
- F. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.
- G. Air Outlet: Adjustable pattern diffuser on vertical projection models and two way louvers on horizontal projection models.
- H. Totally Enclosed Motors: Permanently lubricated sleeve bearings on horizontal models, grease lubricated ball bearings on vertical models.
- I. Control: Local solid state disconnect switch.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are suitable for installation.
- B. Verify that field measurements are as indicated on the drawings.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's recommendations.
- B. Do not damage equipment or finishes.
- C. Unit Heaters:
 - 1. Hang from building structure, with pipe hangers anchored to building, not from piping or electrical conduit.
 - 2. Mount as high as possible to maintain greatest headroom unless otherwise indicated.
- D. Units with Hydronic Coils:
 - 1. Provide with shut-off valve on supply piping and tamper-proof, balancing valve with memory stop on return piping.
 - 2. If not easily accessible, extend air vent to exterior surface of cabinet for ease of servicing.
 - 3. Provide float operated automatic air vents with stop valve for unit heaters.

3.03 CLEANING

- A. After construction and painting is completed, clean exposed surfaces of units.
- B. Touch-up marred or scratched surfaces of factory-finished cabinets using finish materials furnished by the manufacturer.

END OF SECTION

SECTION 26 05 00 BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Basic Electrical Requirements and materials specifically applicable to Division 26 Sections. Section includes:
 - 1. Electrical Identification.
 - 2. Minor Demolition.
 - 3. Conductors and Devices.
 - 4. Raceways and Boxes.
 - 5. Supporting Devices.

1.02 REGULATORY REQUIREMENTS

- A. Conform to construction standards as adopted by the Illinois Community College Board to include:
 - 1. International Building Code 2003 Edition.
 - 2. National Electrical Code ANSI/NFPA 70 2002 Edition.
 - 3. Life Safety Code NFPA 101 2003 Edition.
 - 4. Fire Prevention and Safety 41ILCS100.
- B. Conform to building codes as adopted by the local authority having jurisdiction, where applicable.
- C. Install electrical Work in accordance with the NECA Standard of Installation.

1.03 DELIVERY, STORAGE AND HANDLING

- A. Store and protect all materials as specified under the provisions of Section 01 60 00 and as specified herein.
- B. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.
- C. Ship products to the job site in their original packaging. Receive and store products in a suitable manner to prevent damage or deterioration. Keep equipment upright at all times.
- D. Investigate the spaces through which equipment must pass to reach its final destination. Coordinate with the manufacturer to arrange delivery at the proper stage of construction and to provide shipping splits where necessary.

1.04 PROJECT/SITE CONDITIONS

- A. Install work in locations shown on Drawings, unless prevented by Project conditions. Drawings have omitted certain branch circuitry in areas for ease of reading. All branch circuitry is to be provided by Contractor.
- B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission from Architect/Engineer before proceeding as specified under modification procedures.

1.05 QUALITY ASSURANCE

- A. Provide Work as required for a complete and operational electrical installation.
- B. All products shall be designed, manufactured, and tested in accordance with industry standards. Standards, organizations, and their abbreviations as used hereafter, include the following:
 - 1. American National Standards Institute, Inc (ANSI).
 - 2. American Society for Testing and Materials (ASTM).
 - 3. National Electrical Manufacturers Association (NEMA).
 - 4. Underwriters Laboratories, Inc. (UL).
- C. Install all Work in accordance with the NECA Standard of Installation.

1.06 SUBMITTALS

A. Submit all requested items in Division 26 Sections under provisions of Section 01 30 00.

1.07 PROJECT RECORD DOCUMENTS

A. Cooperate and assist in the preparation of project record documents under the provisions of Section 01 78 00.

1.08 TRENCHING, FILL AND COMPACTION

A. Provide trenching, fill and compaction for all work indicated on Drawings and specified in Division 26 sections.

1.09 PROJECT MANAGEMENT AND COORDINATION

A. Proper project management and coordination is critical for a successful project. Manage and coordinate the Work with all other trades in accordance with Section 01 30 00 requirements. Reliance on the Drawings and Specifications only for exact project requirements is insufficient for proper coordination.

PART 2 PRODUCTS

2.01 WIRING METHODS

- A. All locations: Building wire in raceway.
- B. Use no wire smaller than 12 AWG for power and lighting circuits, and no smaller than 14 AWG for control wiring.
 - 1. Use 10 AWG conductor for 20 ampere, 120 volt branch circuit home runs longer than 100 feet. Use minimum #10 AWG conductor wire in all the following locations:
 - a. All programmable panel branch circuits (larger where indicated).
 - b. All emergency lighting and exit branch circuits.

2.02 WIRE AND CABLE

- A. Manufacturers:
 - 1. Okonite.
 - 2. Southwire.
 - 3. Collyer.

- B. Building Wire:
 - 1. Feeders and Branch Circuits Larger Than 6 AWG: Copper, stranded conductor, 600 volt insulation.
 - 2. Feeders and Branch Circuits 6 AWG and Smaller: Copper conductor, 600 volt insulation. 6 and 8 AWG, stranded conductor; smaller than 8 AWG, stranded conductor (solid for device terminations).
 - 3. Control Circuits: Copper, stranded conductor, 600 volt insulation.
 - 4. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet.
 - 5. Use 10 AWG conductors for 20 ampere, 277 volt branch circuits longer than 200 feet.
 - 6. Use conductor not smaller than 12 AWG for power and lighting circuits.
 - 7. Use conductor not smaller than 16 AWG for control circuits.
- C. Locations:
 - 1. Concealed Dry Interior Locations: Use only building wire with Type THHN insulation in raceway.
 - 2. Exposed Dry Interior Locations: Use only building wire with Type THHN insulation in raceway.
 - 3. Above Accessible Ceilings: Use only building wire with Type THHN insulation in raceway.
 - 4. Wet or Damp Interior Locations: Use only building wire with Type THWN insulation in raceway.
 - 5. Exterior Locations: Use only building wire with Type XHHW insulation in raceway.
 - 6. Underground Installations: Use only building wire with Type XHHW insulation in raceway.

2.03 WIRING DEVICES AND WALL PLATES

- A. Single Pole Switch: Specification grade.
 - 1. Hubbell Model 1121.
 - 2. P & S Model 521.
 - 3. Leviton Model 1121.
 - 4. Color: Ivory.
- B. Duplex Convenience Receptacle: Nema 5-20R, duplex, specification grade.
 - 1. Hubbell.
 - 2. Bryant.
 - 3. Leviton.
 - 4. Color: Ivory.
- C. Decorative Cover Plate:
 - 1. Hubbell.
 - 2. Bryant.
 - 3. Leviton.
 - 4. Description: Ivory, metal.
- D. Weatherproof die cast cover.
 - 1. Intermatic Model WP1030MC (Two-Gang).
 - 2. Approved Equal.

2.04 RACEWAY REQUIREMENTS

- A. Use only specified raceway in the following locations:
 - 1. Branch Circuits and Feeders:

- a. Concealed Dry Interior Locations: Electrical metallic tubing.
- b. Exposed Dry Interior Finished Locations: Electrical metallic tubing.
- c. Exposed Dry Interior Unfinished Locations: Electrical metallic tubing.
- d. All other locations: Galvanized Rigid Metallic Conduit.
- B. Size raceways for conductor type installed.
 - 1. Minimum Size Conduit Homerun to Panelboard: 3/4-inch.

2.05 METALLIC CONDUIT AND FITTINGS

- A. Conduit:
 - 1. Rigid Steel Conduit: ANSI C80.1.
 - 2. Electrical metallic tubing: ANSI C80.3.
 - 3. Flexible Conduit: UL 1, zinc-coated steel.
 - a. Liquidtight Flexible Conduit: UL360. Fittings shall be specifically approved for use with this raceway.
- B. Conduit Fittings:
 - 1. Metal Fittings and Conduit Bodies: NEMA FB 1.
 - a. EMT fittings: Use set-screw indentor-type fittings.

2.06 NONMETALLIC TUBING

- A. Manufacturers:
 - 1. Carlon Co.
 - 2. LCP National Plastics, Inc.
 - 3. Pacific Western Extruded Plastics Co.
- B. Description: UL651A "Type EB and A PVC Conduit and HDPE Conduit."
 - 1. Conduit: Schedule 40. Suitable for exposure to sunlight and direct burial.

2.07 CONDUIT HANGERS

- A. Manufacturers:
 - 1. Minerrallac Electric Company.
 - 2. Substitutions: Or Approved Equal.
- B. Description:
 - 1. Standard conduit hanger, zinc-plated steel with bolts.
 - 2. Threaded rod and hardware: Plated finish, size and length as required for loading and conditions.

2.08 BEAM CLAMPS

- A. Manufacturers:
 - 1. Appleton.
 - 2. Midwest.
 - 3. Raco.
- B. Description: Malleable beam clamp, zinc plated steel.

2.09 ELECTRICAL BOXES

- A. Manufacturers:
 - 1. Raco.
 - 2. Steel City.
 - 3. Appleton.
 - 4. Substitutions: Or Approved Equal.
- B. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1, galvanized steel, suitable for installation in masonry:
- C. Equipment Support Boxes: Rated for weight of equipment supported; include 2 inch male fixture studs where required.
- D. Wet Location Outlet Boxes: Cast aluminum: Cast alloy, deep type, gasket cover, threaded hubs.

2.10 PENETRATION SEALANTS

- A. Fire-rated assemblies: Provide firestopping of all penetrations made by Work.
- B. Thermal and Moisture Protection: Provide thermal and moisture protection made by Work.

2.11 WIREWAY

- A. Manufacturers:
 - 1. Hoffman.
 - 2. Cooper Industries.
 - 3. Approved Equal.
- B. Description:
 - 1. NEMA Type 1 Lay-In Galvanized Wireway, UL 870. Flat cover design. Size as shown on drawings.
 - 2. Provide hinged covers where noted on drawings.
 - 3. Provide all elbows, tee's, covers and fittings as required
- C. Finish:
 - 1. To be selected by Architect/Engineer.

2.12 NAMEPLATES AND LABELS

- A. Nameplates: Engraved three-layer laminated plastic, black letters on white background.
- B. Locations:
 - 1. Each electrical distribution and control equipment enclosure.
- C. Letter Size:
 - 1. Use 1/8 inch letters for identifying individual equipment and loads.
 - 2. Use 1/4 inch letters for identifying grouped equipment and loads.
- D. Labels: Embossed adhesive tape, with 3/16 inch white letters on a black background. Use only for identification of individual wall switches and receptacles and control device stations.

2.13 WIRE AND CABLE MARKERS

- A. Manufacturers:
 - 1. Brady Model PCPS.
 - 2. Panduit Model PCM.
 - 3. T & B Model WM.
- B. Description: Cloth type wire markers.
- C. Locations: Each conductor at panelboard gutters, pull boxes, and each load connection.
- D. Legend:
 - 1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.

2.14 CONDUIT MARKERS

- A. Location: Furnish markers for each conduit longer than 6 feet.
- B. Spacing: 20 feet on center.
- C. Color:
 - 1. 480 Volt System: Orange
 - 2. 208 Volt System: Black
 - 3. Fire Alarm System: Red.

2.15 UNDERGROUND WARNING TAPE

A. Description: 4 inch wide plastic tape, detectable type, colored red with suitable warning legend describing buried electrical lines.

PART 3 EXECUTION

3.01 EXAMINATION AND PREPARATION

- A. Demolition Drawings are based on casual field observation and are intended to identify the limits of the construction site. Remove all electrical systems in their entirety in proper sequence with the Work.
- B. Disconnect electrical systems in walls, floors, and ceilings for removal.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- D. Beginning of demolition means installer accepts existing conditions.
- E. Verify that supporting surfaces are ready to receive work.
- F. Electrical boxes are shown on Drawings, in approximate locations, unless dimensioned.
 1. Obtain verification from Architect/Engineer for locations of outlets throughout prior to rough-in.
- G. Degrease and clean surfaces to receive wire markers.
- H. Verify that interior of building is physically protected from weather.

- I. Verify that mechanical work which is likely to injure conductors has been completed.
- J. Completely and thoroughly swab raceway system before installing conductors.

3.02 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Remove all existing electrical installations to accommodate new construction.
- B. Remove abandoned wiring to source of supply.
- C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- D. Relocate existing fire alarm devices affected by wall, ceiling and floor demolition.
- E. Repair adjacent construction and finishes damaged during demolition and extension work.
- F. Properly dispose of all ballast to approved ballast recycler. Do not land fill ballasts.

3.03 APPLICATION

- A. Install nameplate and label parallel to equipment lines.
- B. Secure nameplate to equipment front using screws.
- C. Secure nameplates to inside surface of door on panelboard that is recessed in finished locations.
- D. Identify underground conduits using underground warning tape. Install one tape per trench at 3 inches below finished grade.
- E. Neatly train and secure wiring inside boxes, equipment, and panelboards.
- F. Use wire pulling lubricant for pulling 4 AWG and larger wires.
- G. Route wire and cable as required to meet project conditions.
 - 1. Wire and cable routing indicated is approximate unless dimensioned.
 - 2. Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.
- H. Pull all conductors into raceway at same time.
- I. Protect exposed cable from damage.
- J. Neatly train and lace wiring inside boxes, equipment and panelboards.
- K. Support cables above accessible ceilings to keep them from resting on ceiling tiles.
- L. Make splices, taps, and terminations to carry full ampacity of conductors without perceptible temperature rise.
- M. Use split bolt connectors for copper conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.
- N. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation".
- O. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.

- P. Do not use powder-actuated anchors.
- Q. Do not drill or cut structural members.
- R. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
- S. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- T. In wet and damp locations use steel channel supports to stand cabinets and panelboards one inch off wall.
- U. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
- V. Terminate spare conductors with electrical tape.
- W. Install wiring devices in accordance with manufacturer's instructions.
 - 1. Install wall switches at height shown on drawings, OFF position down.
 - 2. Install convenience receptacles at height shown on drawings grounding pole on bottom.
 - 3. Install specific purpose receptacles at heights shown on Drawings.
- X. Install wall plates flush and level.
 - 1. Install decorative plates on switch, receptacle, and blank outlets in finished areas.
 - 2. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface-mounted outlets.

END OF SECTION

SECTION 26 05 05 SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical demolition.

1.02 RELATED REQUIREMENTS

A. Section 01 70 00 - Execution and Closeout Requirements: Additional requirements for alterations work.

1.03 SUMMARY

- A. Section Includes:
 - 1. Electrical demolition: Remove electrical systems shown on drawings. Also include:
 - a. Modify connections to mechanical equipment indicated to be removed or replaced.
 - b. Remove and reinstall electrical systems on building construction indicated to be demolished and reconstructed to make access for mechanical equipment.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that abandoned wiring and equipment serve only abandoned facilities.
- B. Beginning of demolition means installer accepts existing conditions.
- C. Demolition Drawings are based on casual field observation and are intended to identify the limits of the construction site. Remove all electrical systems in their entirety in proper sequence with the Work.

3.02 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- C. Existing Electrical Service and Emergency Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from Owner and Architect at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

D. Existing Fire Alarm System: Maintain existing system in service. Disable system only to make switchovers and connections. Notify Owner, Architect/Engineer and local fire service at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Remove, relocate, and extend existing installations to accommodate new construction.
- B. Remove abandoned wiring to source of supply.
- C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- E. Repair adjacent construction and finishes damaged during demolition and extension work.
- F. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- G. Relocate existing fire alarm devices affected by wall, ceiling and floor demolition.
- H. Properly dispose of all ballast to approved ballast recycler. Do not land fill ballasts. **END OF SECTION**

SECTION 26 22 00 LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General purpose transformers.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 00 Basic Electrical Requirements.
- B. Section 26 24 16 Panelboards.

1.03 REFERENCE STANDARDS

- A. 10 CFR 431, Subpart K Energy Efficiency Program for Certain Commercial and Industrial Equipment Distribution Transformers; Current Edition.
- B. IEEE C57.94 IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers; 1982 (R2006).
- C. IEEE C57.96 Guide for Loading Dry-Type Distribution and Power Transformers; 2013.
- D. NECA 1 Standard for Good Workmanship in Electrical Construction; 2010.
- E. NECA 409 Standard for Installing and Maintaining Dry-Type Transformers; 2009.
- F. NEMA ST 20 Dry-Type Transformers for General Applications; 2014.
- G. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- H. NEMA TP 1 Guide for Determining Energy Efficiency for Distribution Transformers; National Electrical Manufacturers Association; 2002.
- I. NEMA TP 2 Standard Test Method for Measuring the Energy Consumption of Distribution Transformers; National Electrical Manufacturers Association; 2005.
- J. NEMA TP 3 Standard for the Labeling of Distribution Transformer Efficiency; National Electrical Manufacturers Association; 2000.
- K. NETA ATS Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- L. NFPA 70 National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- M. UL 506 Standard for Specialty Transformers; Current Edition, Including All Revisions.
- N. UL 1561 Standard for Dry-Type General Purpose and Power Transformers; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the work with placement of support framing and anchors required for mounting of transformers.

1.05 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Include voltage, kVA, impedance, tap configurations, insulation system class and rated temperature rise, efficiency, sound level, enclosure ratings, outline and support point dimensions, weight, required clearances, service condition requirements, and installed features.
- C. Shop Drawings: Provide dimensioned plan and elevation views of transformers and adjacent equipment with all required clearances indicated.
 - 1. For circuit breakers feeding transformers, provide circuit breaker time-current curves overlayed with transformer inrush, FLA and primary/secondary thermal limit curves.
- D. Field Quality Control Test Reports.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Maintenance Data: Include recommended maintenance procedures and intervals.
- G. Project Record Documents: Record actual locations of transformers.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Schneider Electric; Square D Products: www.schneider-electric.us.
- B. Source Limitations: Furnish transformers produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 TRANSFORMERS - GENERAL REQUIREMENTS

A. Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed, classified, and labeled as suitable for the purpose intended.

- B. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:
 - 1. Altitude: Less than 3,300 feet.
 - 2. Ambient Temperature:
 - a. Greater than 10 kVA: Not exceeding 104 degrees F.
 - b. Less than 10 kVA: Not exceeding 77 degrees F.
 - 3. Ambient Temperature: Not exceeding 86 degrees F average or 104 degrees F maximum measured during any 24 hour period.
- C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.
- D. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.
- E. Basic Impulse Level: 10 kV.
- F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.
- G. Isolate core and coil from enclosure using vibration-absorbing mounts.
- H. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.
- I. Case Temperature: Do not exceed 35 degrees C rise above ambient at hottest spot.

2.03 GENERAL PURPOSE TRANSFORMERS

- A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.
- B. Primary Voltage: 480 volts delta, 3 phase.
- C. Secondary Voltage: 208Y/120 volts, 3 phase.
- D. Insulation System and Allowable Average Winding Temperature Rise:
 - 1. Less than 15 kVA: Class 180 degrees C insulation system with 115 degrees C average winding temperature rise.
 - 2. 15 kVA and Larger: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.
- E. Coil Conductors: Continuous copper windings with terminations brazed or welded.

F. Winding Taps:

- 1. Less than 3 kVA: None.
- 2. 3 kVA through 15 kVA: Two 5 percent full capacity primary taps below rated voltage.
- 3. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.
- 4. 500 kVA and Larger: Two 2.5 percent full capacity primary taps above and two 2.5 percent full capacity primary taps below rated voltage.

- G. Energy Efficiency: Comply with 10 CFR 431, Subpart K.
 - 1. Test efficiency according to NEMA TP 2.
 - 2. Label transformer according to NEMA TP 3.
- H. Sound Levels: Standard sound levels complying with NEMA ST 20.
- I. Mounting Provisions:
 - 1. Less than 15 kVA: Suitable for wall mounting.
 - 2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.
 - 3. Larger than 75 kVA: Suitable for floor mounting.
- J. Transformer Enclosure: Comply with NEMA ST 20.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - 2. Construction: Steel.
 - a. Less than 15 kVA: Totally enclosed, non-ventilated.
 - b. 15 kVA and Larger: Ventilated.
 - 3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
 - 4. Provide lifting eyes or brackets.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that suitable support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.
- C. Perform pre-installation tests and inspections on transformers per manufacturer's instructions and as specified in NECA 409. Correct deficiencies prior to installation.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install transformers in accordance with NECA 409 and IEEE C57.94.
- D. Use flexible conduit, under the provisions of Section , 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- E. Arrange equipment to provide minimum clearances as specified on transformer nameplate and in accordance with manufacturer's instructions and NFPA 70.
- F. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by the manufacturer.
- G. Mount floor-mounted transformers using vibration isolators suitable for isolating the transformer noise from the building structure.

- H. Provide grounding and bonding in accordance with Section 26 05 26.
- I. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.
- J. Where not factory-installed, install lugs sized as required for termination of conductors as indicated.

3.03 ADJUSTING

- A. Measure primary and secondary voltages and make appropriate tap adjustments.
- B. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.04 CLEANING

- A. Clean dirt and debris from transformer components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION
SECTION 26 24 16 PANELBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Power distribution panelboards.
- B. Lighting and appliance panelboards.
- C. Overcurrent protective devices for panelboards.

1.02 REFERENCE STANDARDS

- A. FS W-C-375 Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision E, 2013.
- B. NECA 1 Standard for Good Workmanship in Electrical Construction; 2010.
- C. NECA 407 Standard for Installing and Maintaining Panelboards; 2009.
- D. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- E. NEMA KS 1 Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.
- F. NEMA PB 1 Panelboards; 2011.
- G. NEMA PB 1.1 General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; 2013.
- H. NETA ATS Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- I. NFPA 70 National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. UL 50 Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- K. UL 50E Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- L. UL 67 Panelboards; Current Edition, Including All Revisions.
- M. UL 489 Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- N. UL 869A Reference Standard for Service Equipment; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.

- 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
- 3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
- 4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
- 5. Notify Architect/Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
 - 1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 - 1. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
- F. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.07 WARRANTY

- A. Remote Power Switching System at Programmable Panelboards:
 - 1. Provide five years manufacturer's warranty.
 - 2. Warranty: Include coverage of microprocessor, breakers, and interface module.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Schneider Electric; Square D Products: www.schneider-electric.us.
- B. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 PANELBOARDS - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Ambient Temperature:
 - a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
- C. Short Circuit Current Rating:
 - 1. Provide panelboards with listed short circuit current rating as indicated on the drawings.
 - 2. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
- D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- G. Bussing: Sized in accordance with UL 67 temperature rise requirements.
 - 1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
 - 2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- H. Conductor Terminations: Suitable for use with the conductors to be installed.
- I. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 - 2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.

- 3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
 - c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
- 4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
- K. Provide terminals rated and U.L. listed for use with 75 degrees C temperature rated conductors.

2.03 LIGHTING AND APPLIANCE PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
 - 2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
 - 1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
 - 2. Phase and Neutral Bus Material: Copper.
 - 3. Ground Bus Material: Copper.
- D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.
 - 1. UL listed for intended branch circuits:
 - a. Lighting SWD.
 - b. Heating, Ventilating and Air Conditioning: HACR rated.
 - c. Shunt Trip Device: 120 volts, AC.
 - d. Undervoltage Trip Device: 120 volts, AC.
 - e. Auxiliary Switch: 120 volts, AC.
 - f. Alarm Switch: 120 volts, AC.
 - g. Electrical Operator: 120 volts, AC.
 - h. Handle Lock: Include provisions for sealing.
 - i. Provide mechanical trip device.
 - j. Provide insulated ground lug in each enclosure.
 - k. Provide products suitable for use as service entrance equipment where so applied.
- E. Enclosures:
 - 1. Provide surface-mounted or flush-mounted enclosures as indicated.
 - 2. Fronts: Provide lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
 - 3. Provide clear plastic circuit directory holder mounted on inside of door.

2.04 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:

- 1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
- 2. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - 1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 - c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
- 3. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Lug Material: Copper, suitable for terminating copper conductors only.
- 4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
- 5. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive panelboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E. Provide required supports in accordance with Section 26 05 29.
- F. Install panelboards plumb.
- G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.

- I. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.
- J. Provide grounding and bonding in accordance with Section 26 05 26.
- K. Install all field-installed branch devices, components, and accessories.
- L. Provide filler plates to cover unused spaces in panelboards.
- M. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
- N. Provide typed or neatly handwritten circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.
- O. Provide engraved plastic nameplates.
- P. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Identify each as SPARE.
 - 1. Minimum spare conduits: 5 empty 3/4 inch.
- Q. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

R.

3.03 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.04 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.
- C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.05 CLEANING

- A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 27 17 EQUIPMENT WIRING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical connections to equipment and devices not and integral part of the electrical distribution system.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 00 Basic Electrical Requirements
- B. Section 26 28 16.16 Enclosed Switches: Disconnect switches not specified in equipment sections.

1.03 REFERENCE STANDARDS

- A. NEMA WD 1 General Color Requirements for Wiring Devices; 1999 (R 2010).
- B. NEMA WD 6 Wiring Devices Dimensional Specifications; 2012.
- C. NFPA 70 National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Provide conduit rough-in and electrical connection to powered equipment and devices identified in the Project Manual and on the Drawings. Refer specifically, but not limited to, these Specification Sections for further information:
 - 1. Section 22 30 00 Plumbing Equipment.
 - 2. Section 23 09 23 Direct-Digital Control System for HVAC.
 - 3. Section 23 21 23 Hydronic Pumps.
 - 4. Section 23 52 16 Condensing Boilers.
 - 5. Section 23 55 33 Fuel-Fired Unit Heaters.
 - 6. Section 23 82 00 Convection Heating and Cooling Units.
- B. Coordination: Determine connection locations and requirements for furniture, equipment and devices furnished or provided under other sections.
 - 1. Do not rely solely on the Drawings and Project Manual for execution of the Work of this Section.
 - 2. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions.
 - 3. Include necessary field evaluation time to inspect connection requirements.
 - 4. Coordinate with other trades to determine exact rough-in requirements.
- C. Sequencing:
 - 1. Install rough-in of electrical connections before installation of furniture and equipment is required.
 - 2. Make electrical connections before required start-up of equipment.

1.05 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
 - 1. Colors: Conform to NEMA WD 1.
 - 2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
 - 3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
 - 4. Product: Carol.
- B. Disconnect Switches: As specified in Section 26 28 16.16 and in individual equipment sections.
- C. Wiring Devices: As specified in Section 26 05 00.
- D. Flexible Conduit: As specified in Section 26 05 00.
- E. Wire and Cable: As specified in Section 26 05 00.
- F. Boxes: As specified in 26 05 00.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.

- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION

SECTION 26 28 16.16 ENCLOSED SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Enclosed safety switches.

1.02 REFERENCE STANDARDS

- A. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- B. NEMA KS 1 Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.
- C. NETA ATS Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- D. NFPA 70 National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. UL 50 Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- F. UL 50E Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- G. UL 98 Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 4. Notify Architect/Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.
- C. Project Record Documents: Record actual locations of enclosed switches.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

1.07 FIELD CONDITIONS

A. Maintain ambient temperature between -22 degrees F and 104 degrees F during and after installation of enclosed switches.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Eaton Corporation: www.eaton.com.
- B. General Electric Company: www.geindustrial.com.
- C. Schneider Electric; Square D Products: www.schneider-electric.us.

2.02 ENCLOSED SAFETY SWITCHES

- A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature: Between -22 degrees F and 104 degrees F.
- D. Horsepower Rating: Suitable for connected load.
- E. Voltage Rating: Suitable for circuit voltage.
- F. Short Circuit Current Rating:
 - 1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
- G. Provide with switch blade contact position that is visible when the cover is open.
- H. Conductor Terminations: Suitable for use with the conductors to be installed.
- I. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.
- J. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:

- K. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
- L. Heavy Duty Switches:
 - 1. Comply with NEMA KS 1.
 - 2. Conductor Terminations:
 - a. Lug Material: Copper, suitable for terminating copper conductors only.
 - 3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.
- M. Fusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch, horse power rated.
- N. Nonfusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch, horse power rated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed safety switches.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required supports in accordance with Section 26 05 00.
- E. Install enclosed switches plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.03 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

C. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.04 CLEANING

- A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish. **END OF SECTION**

SECTION 26 29 13 ENCLOSED CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Enclosed NEMA controllers for low-voltage (600 V and less) applications:
 - 1. Magnetic motor starters.
 - 2. Motor-starting switches without overload protection.
- B. Overcurrent protective devices for motor controllers, including overload relays.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 00 Basic Electrical Requirements.
- B. Section 26 27 17 Equipment Wiring.

1.03 REFERENCE STANDARDS

- A. IEEE C57.13 IEEE Standard Requirements for Instrument Transformers; 2008.
- B. NECA 1 Standard for Good Workmanship in Electrical Construction; 2010.
- C. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- D. NEMA ICS 2 Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2000 (R2005), with errata, 2008.
- E. NEMA ICS 5 Industrial Control and Systems: Control Circuit and Pilot Devices; 2000 (R2010).
- F. NEMA ICS 6 Industrial Control and Systems: Enclosures; 1993 (R2011).
- G. NEMA KS 1 Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.
- H. NETA ATS Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- I. NFPA 70 National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. UL 60947-1 Low-Voltage Switchgear and Controlgear Part 1: General Rules; Current Edition, Including All Revisions.
- K. UL 60947-4-1 Low-Voltage Switchgear and Controlgear Part 4-1: Contractors and Motor-starters - Electromechanical Contractors and Motor-starters; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.

- 2. Coordinate the work to provide motor controllers and associated overload relays suitable for use with the actual motors to be installed.
- 3. Coordinate the work to provide controllers and associated wiring suitable for interface with control devices to be installed.
- 4. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
- 5. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
- 6. Notify Architect/Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
- C. Test Reports: Indicate field test and inspection procedures and test results.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Maintenance Data: Replacement parts list for controllers.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Eaton Corporation: www.eaton.com.
- B. General Electric Company: www.geindustrial.com.
- C. Schneider Electric; Square D Products: www.schneider-electric.us.
- D. Siemens Industry, Inc: www.usa.siemens.com.

2.02 ENCLOSED CONTROLLERS

- A. Provide enclosed controller assemblies consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.

- C. Description: Enclosed controllers complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; ratings, configurations and features as indicated on the drawings.
- D. Service Conditions:
 - 1. Provide controllers and associated components suitable for operation at indicated ratings under the service conditions at the installed location.
- E. Short Circuit Current Rating:
 - 1. Provide controllers with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
- F. Conductor Terminations: Suitable for use with the conductors to be installed.
- G. Enclosures:
 - 1. Comply with NEMA ICS 6.
 - 2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1 or Type 12.
 - b. Outdoor Locations: Type 3R or Type 4.
 - 3. Finish: Manufacturer's standard unless otherwise indicated.
- H. Instrument Transformers:
 - 1. Comply with IEEE C57.13.
 - 2. Select suitable ratio, burden, and accuracy as required for connected devices.
 - 3. Current Transformers: Connect secondaries to shorting terminal blocks.
 - 4. Potential Transformers: Include primary and secondary fuses with disconnecting means.
- I. Magnetic Motor Starters: Combination type unless otherwise indicated.
 - 1. Combination Magnetic Motor Starters: NEMA ICS 2, Class A combination motor controllers with magnetic contactor(s), externally operable disconnect and overload relay(s).
 - 2. Configuration: Full-voltage non-reversing unless otherwise indicated.
 - 3. Minimum Starter Size: NEMA Size 0. NEMA starter size as scheduled:
 - a. Nema Size 0: Up to 2 horsepower (480 volt), Up to 1 horsepower (208 volt)
 - b. Nema Size 1: 2 to 7.5 horsepower (480 volt), 1 to 5 horsepower (208 volt)
 - c. Nema Size 2: 10 to 25 horsepower (480 volt), 7.5 to 10 horsepower (208 volt)
 - d. Nema Size 3: 30 to 50 horsepower (480 volt), 15 to 25 horsepower (208 volt)
 - 4. Use of non-standard starter sizes smaller than specified standard NEMA sizes is not permitted.
 - 5. Disconnects: Disconnect switch type.
 - a. Disconnect Switches: Fusible or nonfusible type as indicated.
 - b. Provide externally operable handle with means for locking in the OFF position. Provide safety interlock to prevent opening the cover with the disconnect in the ON position with capability of overriding interlock for testing purposes.
 - c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
 - 6. Overload Relays: Bimetallic thermal type unless otherwise indicated.
 - 7. Pilot Devices Required:

- a. Furnish local pilot devices for each unit as specified below unless otherwise indicated on drawings.
- b. Single-Speed, Non-Reversing Starters:
 - 1) Pushbuttons: START-STOP.
 - 2) Selector Switches: HAND/OFF/AUTO.
 - 3) Indicating Lights: Red ON, Green OFF.
- J. Motor-Starting Switches: Horsepower-rated switches without overload protection; toggle operator.

2.03 CONTROL ACCESSORIES

- A. Auxiliary Contacts:
 - 1. Comply with NEMA ICS 5.
 - 2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each magnetic motor starter, minimum.
- B. Pilot Devices:
 - 1. Comply with NEMA ICS 5; heavy-duty type.
 - 2. Pushbuttons: Unless otherwise indicated, provide momentary, non-illuminated type with flush button operator; normally open or normally closed as indicated or as required.
 - 3. Selector Switches: Unless otherwise indicated, provide maintained, non-illuminated type with knob operator; number of switch positions as indicated or as required.
 - 4. Indicating Lights: Push-to-test type unless otherwise indicated.
 - 5. Provide LED lamp source for indicating lights and illuminated devices.
- C. Control and Timing Relays:
 - 1. Comply with NEMA ICS 5.
 - 2. Provide number and type of relays indicated or required to perform necessary functions.
- D. Control Power Transformers:
 - 1. Size to accommodate burden of contactor coil(s) and all connected auxiliary devices.
 - 2. Include primary and secondary fuses.

2.04 ACCESSORIES

- A. Auxiliary Contacts: NEMA ICS 2, 2 normally open contacts in addition to seal-in contact.
- B. Cover Mounted Pilot Devices: NEMA ICS 5, standard duty oiltight type.
- C. Pushbuttons: Unguarded type.
- D. Indicating Lights: LED type.
- E. Selector Switches: Rotary type.
- F. Control Power Transformers: 120 volt secondary, 100 VA minimum, in each motor starter. Provide fused primary, secondary, and bond unfused leg of secondary to enclosure.

2.05 DISCONNECTS

A. Combination Controllers: Combine motor controllers with disconnects in common enclosure. Obtain IEC Class 2 coordinated component protection.

- B. Thermal Magnetic Circuit Breakers: Integral thermal and instantaneous magnetic trip in each pole; UL listed.
- C. Motor Circuit Protector: Circuit breakers with integral instantaneous magnetic trip in each pole; UL listed.
- D. Nonfusible Switch Assemblies: NEMA KS 1, enclosed knife switch with externally operable handle.
 - 1. Type HS or GS, horsepower rated
 - 2. Externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in the OFF position.
- E. Enclosures:
 - 1. Interior Dry Locations: Type 1.
 - 2. Exterior Locations: Type 3R.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that ratings of enclosed controllers are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed controllers.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install controllers in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Install enclosed controllers plumb and level.
- E. Provide grounding and bonding in accordance with Section 26 05 26.
- F. Install all field-installed devices, components, and accessories.
- G. Height: 5 ft to operating handle.
- H. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- I. Set field-adjustable controllers and associated components according to installed motor requirements, in accordance with manufacturer's recommendations and NFPA 70.
- J. Select and install overload heater elements in motor controllers to match installed motor characteristics.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 Quality Requirements, for additional requirements.
- B. Perform field inspection and testing in accordance with Section 01 40 00.
- C. Inspect and test in accordance with NETA ATS, except Section 4.
- D. Motor Starters: Perform inspections and tests listed in NETA ATS, Section 7.16.1.1. Tests listed as optional are not required.
- E. Correct deficiencies and replace damaged or defective enclosed controllers or associated components.
- F. Perform inspections and tests listed in NETA ATS, Section 7.16.1.

END OF SECTION

SECTION 33 52 16 GAS HYDROCARBON PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe and fittings for natural gas distribution on site outside buildings.

1.02 RELATED REQUIREMENTS

A. Section 22 10 05 - Plumbing Piping.

1.03 REFERENCE STANDARDS

- A. ASME B16.11 Forged Fittings, Socket-welding and Threaded; 2011.
- B. ASME BPVC-IX Boiler and Pressure Vessel Code, Section IX Welding, Brazing, and Fusing Qualifications; 2015.
- C. ASME BPVC Boiler and Pressure Vessel Code; 2015.
- D. ASTM A53/A53M Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- E. ASTM A234/A234M Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2015.
- F. ASTM D2513 Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings; 2014.
- G. AWWA C105/A21.5 Polyethylene Encasement for Ductile-Iron Pipe Systems; 2010.
- H. NFPA 58 Liquefied Petroleum Gas Code; 2014.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with municipality requirements.
- B. Designer Qualifications: Design system under direct supervision of a Professional Engineer licensed in the State in which the Project is located.
- C. Welding Materials and Procedures: Conform to ASME BPVC and applicable state regulations.
- D. Welders Certification: In accordance with ASME BPVC-IX.
- E. Conform to NFPA 58.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers with labeling in place.

PART 2 PRODUCTS

2.01 PIPE

- A. Steel Pipe Below Ground: ASTM A53/A53M, Schedule 40 black:
 - 1. Fittings: ASME B16.11 forged steel, or ASTM A234/A234M wrought steel welding type.
 - 2. Joints: Welded, gas tungsten arc method.
 - 3. Jackets: AWWA C105/A21.5 polyethylene jacket.
- B. Steel Pipe Above Ground: ASTM A53/A53M, Schedule 40 black:
- C. Polyethylene Pipe Below Ground: ASTM D2513, SDR11:
 - 1. Fittings: ASTM D2513.
 - 2. Joints: Mechanical or compression fit.
- D. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Natural Gas Service " in large letters.

2.02 GAS COCKS AND VALVES

- A. Gas Cock and Pressure Regulating Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Gas Cocks Up to 2 Inches: 150 psig water or gas (WOG), bronze body, bronze tapered plug, non-lubricated, Teflon packing, threaded ends with cast iron curb box, cover, and key.
- C. Gas Cocks Over 2 Inches: 125 psig WOG, Steel body and tapered plug, non-lubricated, Teflon packing, threaded ends, with cast iron curb box, cover, and key.
- D. Pressure Regulating Valves: Single stage, malleable iron body, corrosion-resistant, pressure regulator with atmospheric vent, elevation compensator; with threaded ends for 2 inch and smaller, flanged ends larger than 2 inch.
 - 1. Capacity: For inlet and outlet gas pressures, specific gravity, and flow rate indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that building service connection and utility gas main size, location and invert are as indicated.

3.02 PREPARATION

- A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs. Bevel plain end ferrous pipe over 2 inches diameter Thread ferrous pipe 2 inches diameter and under.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections with flanges and unions.

3.03 TRENCHING

A. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.04 INSTALLATION - PIPING

- A. Group piping with other site piping work whenever practical.
- B. Route piping in straight line.
- C. Install piping to conserve space and not interfere with use of site space.
- D. Install piping to allow for expansion and contraction without stressing pipe or joints.
- E. Install cocks and other fittings.
- F. Establish elevations of buried piping to ensure not less than 24 inches of cover in non-travelled areas and 48 inches of cover in driveways and parking areas.
- G. Wrap couplings and fittings of steel pipe with polyethylene tape and heat shrink over pipe.
- H. Install trace wire 6 inches above top of pipe.
- I. Center and plumb valve box over valve. Set box cover flush with finished ground surface. Prevent shock or stress from being transmitted through valve box to valve.
- J. Wrap valve and valve box with polyethylene tape and heat shrink.
- K. Provide regulator vent with rain and insect proof opening, terminating away from building openings.
- L. Paint valves and valve boxes with rust inhibitive primer and one coat of epoxy paint.

END OF SECTION