Project Manual for

STEUBENVILLE CITY SCHOOLS

Steubenville, OH

Steubenville High School STEM Building

HASENSTAB ARCHITECTS

PREPARED BY:

HASENSTAB ARCHITECTS, INC.
190 NORTH UNION STREET, SUITE 400
AKRON, OHIO 44304
TEL. 330.434.4464
FAX. 330.434.8546

Dennis Check, License #8909110
Expiration Date: 12/31/2023

Project No. 21042.000
CD Issue Date: May 20, 2022
Construction Documents
Volume II
Conformed Documents

TABLE OF CONTENTS

DIVISION 5 – METALS

DIVISION 6 – WOOD AND PLASTICS

DIVISION 7 – THERMAL AND MOISTURE PROTECTION

DIVISION 8 – DOORS AND WINDOWS

DIVISION 9 – FINISHES

DIVISION 21 – FIRE SUPPRESSION – Con't.

DIVISION 22 – PLUMBING

DIVISION 22 – PLUMBING (Con't)

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING (Con't)

DIVISION 26 – ELECTRICAL

END OF TABLE OF CONTENTS

SECTION 21 00 10
DOCUMENT INTERPRETATION AND GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications complement the requirements of this section. Contractors and Subcontractors shall also examine Architectural, Structural, Plumbing, Mechanical, Electrical and all other Drawings and Specifications pertinent to this project. The above mentioned Drawings and Specifications for all the Divisions are part of the Contract Documents.

1.2 SCOPE

A. This Section specifies the basic requirements for fire protection installations.

B. This section specifies the applicable Codes of Standards.

C. This section describes the requirements for demolition of Fire Protection equipment, materials, and systems and defines equipment and material salvage rights.

D. This section describes the basic requirements and procedures for shutting down existing, active fire protection systems and includes requirements for temporary services should a system need back fed during an unavoidable shut-down or need to remain operational at all times. Temporary services portion of this section supplements and expands on the requirements of Division 1.

1.3 INFERRED PHRASES

A. Where the words “submit”, “submitted”, “approval”, or “approved” or similar are used without an object of the verb, the phrase shall be assumed to read: “Submit to the Construction Manager”, “Submitted to the Construction Manager”, or “Approved by the Construction Manager” as appropriate, unless otherwise noted.

B. The word “provide” shall be understood to mean “furnish and install”.

C. The word “set” shall be understood to mean “install”

D. Reference is made within these Specifications and on the drawings to “General Contractor”. There is no “General Contractor” on this project per se. There is a Construction Manager on this project. It shall be understood that all references to “General Contractor” shall mean the Trade Contractor assigned by the Construction Manager to perform the work.

1.4 CODES, STANDARDS, AND PERMITS

A. Reference to the codes and standards listed shall constitute the minimum acceptable requirements. Nothing in the Specifications shall be construed to permit deviation from the requirements of the governing code. Where requirements of the Drawings and Specifications exceed those of the code listed, follow the Drawings and Specifications.

B. Drawings and Specifications are to be considered as supplementing each other. Work specified but not shown, or shown but not specified, shall be performed or furnished as though mentioned in both Specifications and Drawings. Where there is a conflict between presented requirements, the more stringent requirement shall apply.

C. The scope of work shall include the furnishing of systems, equipment and materials specified in this division and as called for on the Drawings. Work shall include supervision, operations, methods and labor for the fabrication, installation, start-up and tests for the complete installation.

D. Water Department/Fire Department/Marshal Compliance:

1. Furnish and install fire protection systems in accordance with regulations required by the Water Department and the City Building and Fire Departments. Installation and materials of construction of all piping upstream from the double detector check valve assembly shall comply with all requirements of the City of Water Department.

E. The fire protection systems shall meet all Owner and Owner's Fire Insurance Underwriter requirements.

F. Install work in full accordance with rules and regulations of State, County and City authorities having jurisdiction over premises. This shall include safety requirements of the state and the State of Ohio Division of Industrial Relations and OSHA.

G. All wiring shall be in compliance with the current edition of the National Electric Code, Applicable State Code, applicable local (city) code, and OSHA. In cases of conflict between code and specifications, the more restrictive requirements shall govern.

H. All equipment, materials and installation methods shall comply with the following, where applicable:

1. Building Officials and Code Administrators International (BOCA)
2. Codes and Standards Association (CSA)
3. International Building Code (IBC)
4. International Mechanical Code (IMC)
5. National Electric Code (NEC)
6. National Fire Protection Association (NFPA)
7. National Pressure Vessel Code
8. International Association of Plumbing and Mechanical Officials (IAPMO)
9. NBC, National Building Code of Canada
10. Ohio Building Code (OBC)
11. Ohio Fire Code (OFC)
12. Standard Building Codes (SBC)
13. Standard Mechanical Codes (SMC)
14. Uniform Building Codes (UBC)
15. Uniform Mechanical Codes (UMC)

I. All equipment, materials and installation methods shall comply with the following, where applicable.

1. American National Standards Institute (ANSI)
2. American Society for Testing and Materials (ASTM)
3. American Society of Mechanical Engineers (ASME)
4. American Water Works Association (AWWA)
5. American Welding Society (AWS)
6. Cast Iron Soil Pipe Institute (CISPI)
7. Fluid Sealing Association (FSA)
8. National Institute of Standards and Technology (NIST)

9. National Pressure Vessel Code
10. National Sanitation Foundation (NSF)
11. National Science Foundation (NSF)
12. Plastic Pipe Institute (PPI)
13. Underwriter's Laboratories of Canada (ULC)
14. Underwriters Laboratories, Inc. (UL)

J. This Contractor shall secure and pay for all permits and certificates of inspection required for this work.

K. Deliver all certificates and official records of approval, by governing agencies, to the Architect.

1.5 DESIGN DRAWINGS

A. The Contract Drawings, as submitted, are diagrammatic and are not intended to show exact location of piping and equipment unless dimensions are given. Piping and equipment are to be installed along the general plans shown on the Drawings, but keeping in mind actual building conditions.

B. Because of the scale of the drawings, certain basic items may not be shown, but where such items are required by other Sections of these specifications or where they are required by the nature of the work, they shall be furnished and installed. Rough-in dimensions and locations shall be verified with the supplier of all equipment furnished by other trades or by the Owner prior to the time of roughing-in.

C. All equipment, piping and material specified hereinafter as shown on the Drawings shall be furnished and installed by this Contractor, unless specifically indicated to the contrary.

D. If this Contractor proposes to install equipment requiring space conditions other than those as specified and/or shown on the Contract Drawings, or to rearrange the equipment, he shall assume full responsibility and expense for the rearrangement of the space and shall obtain the full approval of the Architect before proceeding with the work.

E. This Contractor shall locate all equipment that must be serviced, operated or maintained in fully accessible positions. Minor deviations from the Contract Drawings may be made to allow for better accessibility, but changes of magnitude, or which involve extra cost, shall not be made without approval. Ample space shall be allowed for removal of all parts that may require replacement or service in the future.

F. The Drawings and the Specifications are cooperative and supplementary. It is the intent of both said Drawings and Specifications to cover all fire protection requirements in their entirety as nearly as possible. This Contractor shall closely check the Drawings and Specifications for any obvious errors or omissions, and bring any such condition to the attention of the Architect prior to the receipt of bids, in order to permit clarification by means of an Addendum. If there is no question prior to the bid proposal date, the Architect shall assume that the Drawings and Specifications are complete and correct and will expect the intent of said documents to be complied with, and the installation to be complete in all respects according to said intent.

G. This Contractor shall have a complete set of drawings including Architectural, structural, plumbing, mechanical and electrical drawings on the site at all times. Prior to installing any work, this Contractor shall check the drawings for exact dimensions and see that the work does not interfere with clearance required for beams, foundations, finished columns, pilasters, partitions, piping, ductwork, etc., as shown on the drawings and details. After work is installed, if interferences develop that have not been called to the attention of the Architect before the installation, this Contractor shall, at the Contractor's own expense, make such changes in work as directed by the Architect.

H. Extra costs which might result from deviations from the Drawings, so as to avoid interferences, shall be considered a "Job Condition", and no additional compensation will be considered applicable. In the event that such interferences occur in the course of the Work, due to an error, omission, or oversight by the Contractor, no additional compensation shall be allowed. Interferences which may occur during the course of construction shall be brought to the immediate attention of the Architect, and his/her decision, confirmed in writing, shall be final.

1.6 EXAMINATION OF SITE

A. Before submitting a bid, it is recommended that each Contractor visit the site and become familiar with conditions affecting this work. No additional payment will be made on claims that arise from lack of knowledge of existing conditions.

1.7 BASIS OF DESIGN

A. Where more than one manufacturer is listed in the Specifications as being acceptable, it shall be understood that the basis of design manufacturer is the manufacturer included in the equipment schedule or with the model number listed. Subject to project requirements, all other listed manufacturers are considered as acceptable alternatives. If installation of an acceptable alternative alters the design, electrical or space requirements indicated on the Drawings, this Contractor shall bear the costs for the revised design and construction including costs of all trades involved.

1.8 EQUIPMENT AND MATERIALS

A. Prior to the signing of the Contract, the successful bidder may be required to submit to the Architect a list of manufacturers of the major items of equipment he proposes to furnish and the names of any subcontractors he proposes to employ.

B. When two or more items of same equipment type are required (sprinkler heads, etc.) they shall be of the same manufacturer.

C. All equipment and materials shall be new.

D. Provide material and labor which is neither drawn nor specified but which is obviously a component part of and necessary to complete work and which is customarily a part of work of similar character.

1.9 COORDINATION AND SUPERVISION

A. This Contractor shall examine the work of other trades and shall so coordinate and schedule work as not to cause delays or interference with work of others.

B. Determine sizes and locations of structural openings necessary for the installation of fire protection systems. Coordinate these openings and the setting of sleeves with other trades, to accomplish the installation of piping with minimal cutting through concrete or masonry.

C. Coordinate the installation of all required supporting devices, inserts and hangers in structural components as they are constructed.

D. Install fire protection equipment and components (valves, switches, etc.) to facilitate servicing, maintenance and repair or replacement. Coordinate the final location of concealed equipment and components requiring access with the final location of access doors and panels. Allow adequate space for proper servicing, maintenance and repair. Make final connections to equipment with consideration for future disconnection and removal with minimal interference with other installations.

E. Where installation is to occur in an area with no ceiling and mounting heights are not detailed or dimensioned on the Drawings, install equipment components and systems tight to overhead structure to provide maximum possible headroom.

F. Install additional piping offsets as required to obtain maximum headroom or to avoid conflicts with other work, without additional cost to the Owner.

G. Before installing work, report any interference between work of this Division and work of other Divisions to the Architect as soon as they are discovered. The Architect shall determine which work must be relocated, or make adjustments to maintain clearances and required headroom and to avoid conflict with other work. If any work is installed so that the Architectural design cannot be adhered to, this Contractor is liable for cost of making such changes as the Architect may require.

H. Ceiling grid systems shall not be supported from equipment or piping and vice versa. Where interferences occur, in order to support piping, ceiling grid systems, etc., trapeze type hangers or supports shall be employed which shall be located so as not to interfere with access to fire protection equipment such as valves, etc.

I. Provide adequate competent supervision at all times when work is being performed. Cooperate with all other trades to avoid interferences and delays.

1.10 DAMAGE AND EMERGENCY REPAIRS

A. Assume responsibility for any damage caused by leaks in any piping system being installed or reworked under this Contract. Repair all damage without extra cost to Owner. Restore building, piping, insulation etc. to their original condition.

B. The Owner reserves the right to make emergency repairs as required to keep equipment in operation, without voiding Contractor’s guarantee or relieving him of responsibility during the warranty period.

1.11 PROTECTION OF WORK AND PROPERTY

A. The Contractor shall be responsible for safeguarding work, property and facilities against damage, both the Contractor's own, as well as others, with which the Contractor may come into contact in the performance of the work.

B. Stored materials shall be protected against damage from weather. Pipe openings shall be closed with caps or plugs during installation. All equipment shall be covered and protected from damage. Any materials or equipment damaged at any stage in the construction shall be replaced or repaired and shall be in a clean, unblemished condition at project turnover.

C. Protect floors and walls against staining and abrasion from chips and cutting oil where pipe cutting and threading machines are used.

D. Protect equipment and finished surfaces from welding, soldering and burning with baffles and blankets.

E. Use drop cloths to protect finished surfaces from paint and insulation adhesive droppings.

1.12 DELIVERY, STORAGE AND HANDLING

A. This Contractor shall pay all costs for the transportation of materials and equipment, included in this contract, to the job site.

B. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels and other information needed for identification.

C. Each Contractor shall make provisions for the delivery and safe storage of materials and equipment in coordination with the work of others. Materials and equipment shall be delivered at such stages of the work as will expedite the work as a whole and shall be marked and stored in such a way as to be easily checked and inspected.

D. Handle equipment and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged equipment or components; replace with new.

E. Comply with manufacturer’s ringing and installation instructions for unloading equipment and moving them to final location.

1.13 CLEAN-UP

A. Refer to Division 1 for general requirements for final cleaning.

B. Insofar as this Division is concerned, at all times keep premises and building in a neat and orderly condition; follow explicitly any instructions of the Architect and Owner in regard to storing of materials, protective measures, cleaning-up of debris, etc.

C. Upon completion of work remove all tools, equipment, surplus materials, etc. from the project site.

D. Prior to project turn-over thoroughly clean all piping and equipment, removing all dirt, grease, oil and dust. It is recommended that steps are taken to eliminate this dust buildup during construction.

1.14 WARRANTIES

A. This Contractor shall warrant for a period of one year (from the date of final acceptance) that all work and equipment will remain free from all defects in workmanship and materials, and that it will comply with all the specific requirements of the Specifications and other Contract Documents governing the work.

B. All work found by the Architect or Engineer to be defective will be replaced with new work meeting all the requirements of the Contract. This Contractor will bear all costs of supplying such new work, and installing and finishing same, and will assume all costs for replacing other work damaged by the removal and replacement of any of the work.

C. Include copies of all warranties in the operation and maintenance manuals.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 DEMOLITION WORK - SERVICES

A. Active Services: When encountered, support active mechanical services as necessary. If active services require relocation (other than those indicated on the drawings), obtain written instructions before proceeding. Do not disturb active services scheduled to remain.

B. Inactive or Abandoned Services: When encountered, remove inactive and abandoned piping full length. Removal shall include all hangers and supports. Notify servicing utility when encountered outside of structure.

C. Interruption of Service: See "Fire Protection System Shut-downs" section for procedures and requirements.

D. Tie-ins: In areas where new construction ties into existing facilities or in remodeled areas, dismantle the existing fire protection facilities as necessary. Relocate any existing services interfering with construction.

3.2 DEMOLITION WORK - GENERAL

A. Remove all existing piping, devices, controls, wiring and equipment as indicated on the drawings that interfere with new construction or those that are not necessary to maintain service to equipment and devices that are to remain.

B. Relocate, or extend as required, piping that interferes with demolition and is essential to maintain service to equipment and devices that are to remain.

C. Remove or relocate all equipment specifically indicated on the drawings and as required to complete demolition work.

D. In those cases where equipment and devices are removed, the associated piping that will no longer be active shall be removed.

E. All piping to be removed shall be removed full length back to the source or an active line or portion of the system.

F. All holes or damage caused by the removal of existing equipment, devices, and piping shall be properly patched. Holes shall be neatly patched with suitable materials to match existing surfaces.

3.3 SAFE DISPOSAL OF HAZARDOUS MATERIALS

A. The Fire Protection Contractor shall safely dispose of all hazardous materials encountered in full compliance with all Federal and Local EPA regulations.

3.4 SALVAGE

A. All Fire Protection equipment, piping and devices that are to be removed shall be offered to the Owner for salvage. Equipment, piping and devices selected for salvage shall be stored on-site at areas designated by the Owner.

B. All items not selected for salvage by the owner shall become the property of the Fire Protection Contractor and shall be removed from the site by the Fire Protection Contractor.

3.5 GENERAL INSTALLATION REQUIREMENTS

A. Examine areas and conditions where equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

B. Install equipment as indicated, and in accordance with manufacturer's installation instructions. Uncrate units and inspect for damage. Verify that nameplate data corresponds with unit designation.

C. Locate equipment, plumb and level, firmly anchored in locations indicated. Coordinate with other trades to assure correct recess size for recessed units. Hang ceiling units from building substrate, not from piping. Support units with rod-type hanger anchored to building substrate.

D. All equipment shall be installed with adequate clearance provided for routine maintenance and servicing. Locate horizontal, above-ceiling units to maintain access with ceiling components below.

3.6 ADJUSTING AND CLEANING

A. General: After construction is complete, including painting, clean all equipment exposed surfaces.

B. Retouch any marred or scratched surfaces of factory-finish, using finish materials furnished by the manufacturer.

3.7 SYSTEM SHUT-DOWNS

A. General

1. The Contractor shall work with the Owner to schedule and plan required system shutdowns. The Contractor shall identify all necessary shutdowns and shall identify the approximate date(s) shutdowns will be required at the outset of the project.

2. The Owner shall reserve the right to dictate final time and date of all shutdowns. The Contractor shall perform all shutdowns at the time and date as directed by the Owner, even if they are required to be performed on weekends or after normal business hours.

3. The Contractor shall work with the Owner's personnel to identify isolation valves in the existing systems requiring shut-down to properly isolate active portions of the system from the targeted inactive portion of the system. Should isolation valves not be present, or not be functional, the Owner shall be notified of the deficiency. In any case, the shut-down shall still be required and deficiencies of the existing system shall be planned around.

B. Standpipes

1. The Contractor shall isolate the portion of the system where tie-ins or demolition work is to be performed from other portions of the system, as is permitted by the presence of existing isolation valves.

2. The Contractor shall identify all fire department valves and sprinkler systems serviced by each standpipe requiring shut-down upstream of the targeted work area and upstream of the previously identified isolation valve, if any are present.

3. The Contractor shall identify the approximate amount of time required to perform the work which required that the system be taken out of service.

4. The Contractor shall work with the Owner to identify the optimum time and date that the previously identified systems can be taken out of service for the previously identified period of time.

5. The Contractor shall perform the necessary work to the existing standpipe at the previously agreed upon date and time. The Contractor shall follow common piping practices or those as identified in other sections of this division to perform said work.

3.8 TEMPORARY SERVICES

A. Fire Watch

1. Where portions of the existing fire protection system require shut-down for any period of time, the Fire Protection Contractor shall make arrangements for a continuous fire watchman to be present on site for the duration of shut-down to the permanent fire protection system.

2. Fire watch shall be in compliance with all state and local codes, and shall be coordinated with the Authority Having Jurisdiction (AHJ).

B. The Fire Protection Contractor shall provide additional fire extinguishers as required by the Authority Having Jurisdiction (AHJ).

END OF SECTION 21 00 10

SECTION 21 01 10
PROJECT SUBMITTAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section contains:

1. General requirements and procedures for Submittals and Shop Drawings.

2. Requirements for Operation and Maintenance Manuals (O&M manuals) for all Division 21 work.

3. Requirements for record drawings for documentation of installed conditions for all Division 21 work.

B. For specific requirements, see individual specification sections.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Where applicable, the Contractor shall submit:

1. Shop Drawings

2. Operation and Maintenance Manuals

3. Piping System Integrity Test Reports

4. Start-up Reports

5. Record Drawings

B. A list of required submittals are specified in each individual specification section.

3.2 SUBMITTAL PROCEDURES

A. Shop drawings

1. Contractor Review

a. This Contractor shall review, stamp and sign with approval all submittals and deliver with reasonable promptness and in orderly sequence so as to cause no delay in the work or in the work of any other Contractor.

b. Submission of shop drawings without review, signature, and approval shall be cause for rejection. Such submittals shall be returned without review.

c. If the submittal includes deviations from the requirements of the Contract Documents, the Contractor shall clearly note the deviations "in red" on the submittal.

2. Electronic Submission

a. All submittals shall be in electronic format. Electronic submittals shall conform to this specification.

b. Electronic submittals shall conform to the following requirements:

1). Electronic submittals shall be in Portable Document Format (.pdf)

a). Electronic submittals shall include a transmittal.

b). All portions of the electronic submittal shall be bound in a single .pdf file.

c). File shall be named to match submittal name as it appears on the individual specification.

i. Example: "21 23 50 – Dry-Pipe Sprinkler Systems".

d). Submittals shall specifically identify any deviations from the Contract Documents.

2). Electronic submittals shall include a Contractor review stamp that indicates review and approval by the Contractor prior to submission.

3). Electronic submittals shall be transmitted via an e-mail:

a). Provide only one submittal per e-mail

b). E-mail subject line shall clearly indicate:

i. Project name

ii. That the e-mail contains a submittal

iii. Contents of submittal

c. Failure to conform the requirements above may result in rejection.

d. At the Reviewer's discretion, the Reviewer has the option to return the submittals in whatever method is most convenient or appropriate for the Project.

3. Shop Drawing Cover Form

a. All submittals shall include a Cover form.

b. Follow the Architects requirements for the cover form.

c. Cover form shall contain, at a minimum, the following information:

1). Submitting Contractors Contact information

2). Shop Drawing Number and Name (As noted in Project Submittal Requirements)

3). Issue (Original, Resubmittal 1, etc.)

4). Name of equipment manufacturer

5). Name of equipment supplier

d. If the submittal includes deviations from the requirements of the Contract Documents, the Contractor shall clearly indicate such deviations on the shop drawings cover form.

4. Engineer's Review

a. Shop drawings shall be reviewed only for general compliance and not for dimensions or quantities. The Reviewer will make reasonable efforts to detect and correct errors, omissions and inaccuracies but shall not be responsible for failure to detect errors, omissions, or inaccuracies. Failure to detect errors, omissions and inaccuracies shall not relieve the Contractor of responsibility for the proper and complete installation in accordance with the intent of the Contract Documents.

b. The Engineer shall mark the shop drawings in one of the ways outlined below. See each description for interpretation of Engineers marks and Contractor responsibilities associated with each.

1). APPROVED: The submittal complies with the requirements of the specifications.

2). APPROVED AS NOTED: The submittal generally complies with the requirements of the specifications but some non-critical items which need to be corrected/coordinated are noted. The corrections shall be changed on the shop drawings submitted for inclusion in the Operations and Maintenance Manual. Re-submittal is not required unless noted otherwise.

3). REVISE AND RESUBMIT: The submittal generally complies with the requirements of the specifications but some critical items which need to be corrected/coordinated are noted. The submittal must be revised and resubmitted with all comments addressed.

4). REJECTED: The submittal does not comply with the requirements of the specifications. The submittal must be revised and resubmitted.

c. Approval of submittal items shall not eliminate the Engineers right to reject those items if defects are discovered prior to final acceptance of the completed work.

B. Operations and Maintenance Manual

1. Submit one (1) copy of the Division 21 manual to the Architect/Engineer for review.

2. After review, address Architect/Engineer's comments and provide the Owner with three (3) hardbound copies of the final approved operating and maintenance manuals for Division 21. Obtain receipt. Note – Operation and Maintenance manuals are required before Owner training takes place.

C. Record Drawings

1. Submit a complete set of red-lined drawings indicating "as-installed" locations of piping, ductwork, and equipment.

3.3 SHOP DRAWING CONTENT

A. Indicate specific options or accessories on shop drawings by pointing to, checking off, or underlining. Do not use highlighter.

B. Do not reproduce Contract Documents or copy standard information as the basis of shop drawings. Standard information prepared without specific reference to the Project is not considered shop drawings and will be cause for rejection.

C. Shop Drawings shall contain the following information, where applicable.

1. General:

a. Model Number

b. Dimensions

c. Weight

d. Clearance requirements

e. Special rigging requirements

f. Material

g. Color and finish

h. Installation recommendations

i. Ratings

j. All included options and accessories

2. Performance:

a. Performance data as scheduled and/or specified (at a minimum)

b. Code/standard compliance information

c. Pressure drop curve or chart

3. Connections:

a. All pipe and duct connections, including:

1). Size(s)

2). Location(s)

3). Connection service (Supply, return, exhaust, etc.)

4). Connection method

b. Electrical connections:

1). Location(s)

2). Termination lug size(s)

3). Plug NEMA configuration

4. Electrical:

a. Characteristics, including:

1). Voltage/Phase

2). Full load and locked rotor amps

3). Required overcurrent protection and short circuit interrupting capacity

4). Horsepower of motor(s)

b. Power wiring diagram

c. Accessories furnished, including starter(s), disconnect(s), on/off switches, etc.

1). Clearly indicate if accessories are factory or field mounted/wired.

5. Controls:

a. Wiring terminations for required interlock and control wiring

b. Wiring diagram, with factory installed and field installed portions clearly differentiated.

c. Accessories furnished, including thermostat(s), sensor(s), etc.

1). Clearly indicate if accessories are factory or field mounted/wired.

d. Sequences of operation

e. Integration

1). Protocol(s), including baud rate.

2). Available points, with read/write capabilities clearly noted.

3). Registers required for integration.

6. Refer to individual specifications sections for special required information.

3.4 OPERATOR AND MAINTENACE MANUAL FORMAT

A. Binder:

1. Include all materials in a three (3) ring binder or binders, if volume of content dictates multiple books.

2. Provide a type-written cover for the binder indicating project title, contractor firm name and address, date of substantial completion (project finish date), and owner company name.

B. Index:

1. Include a numbered index indicating ALL documents included in the manual.

C. References:

1. Include a page or pages indicating contractor firm name, address, and contact phone number.

2. Indicate the contractor's job foreman, including contact phone number and email address.

3. Indicate all subcontractors utilized, including contact phone numbers and email addresses for each.

4. Name of service agency and installer. Include 24 hour per day emergency phone numbers.

5. Include design Architect reference, including contact phone numbers.

6. Include design Engineer reference.

D. Contents:

1. Provide a separate tabbed section for each specified item type including the following, if applicable:

a. Identification, name, mark, or number as indicated on the design drawings.

b. Final accepted shop drawing, including Engineer's cover form indicating "Accepted" without exception.

c. Manufacturer's maintenance and service manuals including instructions for troubleshooting, disassembly, repair, reassembly, adjusting, aligning, servicing and lubrication.

d. Spare/replacement parts list.

e. Belt sizes, type and lengths (where applicable).

f. Step by step procedures for startup and shutdown of each system and piece of equipment.

g. Copy of equipment start-up report and/or capacity test (if required as part of equipment specification). See Equipment and System Start-up specification section for requirements.

h. Equipment manufacturer's warranty.

2. Automatic controls including device schedules, diagrams and written sequence of operations.

3. Final accepted balance reports as required by this specification.

4. Copy of all system integrity verification report, where required. See Piping Systems Flushing and Testing specification section for requirements.

5. Copy of all piping system flushing, cleaning, and certification reports as required by this Specification.
6. Copy of testing, adjusting, and balancing report as required by this division specification.
7. Copy of Ductwork leakage testing report as required by this division specification.

E. Warranties

1. Contractor warranty including date of final acceptance (this indicates the start of the warranty period).
2. Date of final acceptance shall be issued by the Architect.

F. Electronic Requirements

1. Provide Operations and Maintenance Manuals to Owner and Engineer in .pdf format.

3.5 RECORD DRAWINGS

A. Field Documentation

1. This Contractor shall record all changes from original design drawings made during installation. These changes shall be recorded in red ink on a dedicated copy of the final approved construction or coordination drawings. Changes shall be accurately dimensioned and/or drawn to scale.
2. This Contractor shall keep an updated set of prints, including changes, on the job site at all times and shall submit one (1) set of updated and legible "as-built" prints to the Architect when the work is complete.
3. Prepare record documents in accordance with the requirements in Division 1.
4. In addition to the requirements specified in Division 1, indicate the following installed conditions.
    a. Ductwork mains and branches and locations of balancing dampers, motor operated dampers, control devices, coils, etc.
    b. Piping mains and branches and locations of isolation valves, balance valves, control valves, regulating valves, strainers, expansion devices or loops, air vents, etc.
    c. Locations of all equipment.
    d. Locations of all equipment controllers, control panels, sensors, control devices, etc.
    e. Locations, inverts, and sizes of all underground piping and power.
5. Record documents shall include all deviations from the Contract Documents including any substitutions.
6. If the project requires the preparation of coordination drawings, the coordination drawings shall be submitted as record documents.

END OF SECTION 21 01 10

SECTION 21 01 30
COORDINATION DRAWINGS

PART 1 - GENERAL

1.1 SCOPE

A. This section describes the requirements for coordination of all trades prior to installation of building systems and the requirements of deliverable coordination drawing sets.

B. Provide pre-construction coordination of all trades and coordination drawings as described in this section.

1.2 SUBMITTALS

A. Provide coordination drawings as herein specified.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. The Division 23 contractor shall be the lead coordination contractor. The Division 21 contractor shall prepare coordination drawings for the required Division 21 systems as outlined below and shall provide the drawings in the specified electronic format to the Division 23 contractor for final inclusion in the overall coordination drawings.

B. The Division 21 contractor shall assist the Division 23 contractor in the preparation and coordination of Division 21 systems and shall make all requested and required changes, within reason.

C. Prepare coordination drawings in accordance with Division 1 Section "Project Coordination" and for all areas of the building as follows:

1. Above all ceilings and in all interstitial spaces.

2. For all Mechanical Equipment Rooms and areas where mechanical equipment is installed.

3. For all areas where careful coordination is needed for installation of products for and materials fabricated by separate entities.

D. Secure approval of coordination drawings from other trades affected, prior to submittal to the Architect for review. Each trade must indicate acceptance of illustrated conditions by attaching his endorsement to each drawing.

E. Proceed with installation only after review of coordination drawings by the Architect and Engineer and approval from other trades affected.

F. Plan the development of coordination drawings with the General Contractor’s schedule for work.

1. At the beginning of construction, submit a coordination drawing development schedule including an anticipated drawing list for development tracking.

2. It is anticipated and acceptable for the contractor to submit coordination drawings based on the progression of the work areas identified in the project schedule.

G. This Contractor shall keep a set of signed off coordination drawings, including updated changes, on the job site at all times and shall submit one (1) set of updated and legible "as-built" prints to the Architect when the work is complete.

1. Record any adjustments from original signed-off coordination drawings that were made during the final installation of the work. See Record Drawings specifications section for further procedures and details..
2. Final marked coordination drawings shall be submitted as record documents.

3.2 DRAWING FORMAT

A. Furnish all drawings in AutoCAD 2019 or later or Autodesk Revit 2019 or later, and as agreed upon by all contractors prior to the commencement of coordination efforts.

B. Scale: ¼”=1’-0” minimum

C. Final drawings shall be submitted as hard copy color prints as a shop drawing for review and approval by the Architect and Engineer.

D. Trades and/or systems shall be assigned a separate color for easy distinction. Colors shall be assigned to all supporting divisions by the Division 23 contractor.

3.3 RESTRICTIONS

A. Photocopied, reproduced or traced drawings of the original Contract Documents shall not be used as coordination drawings.

B. Single line drawings of the ductwork layout will not be allowed to be used as part of Coordination Drawings.

C. Electronic files of the original Contract Drawings will not be allowed to be used as coordination drawings.

3.4 REQUIRED SYSTEMS

A. Equipment

1. Include all fire protection equipment, pumps, hose connection locations, test connection locations, fire department backfeed connections.
2. Include fire protection equipment support and concrete pad locations

B. Piping

1. Include all fire, standpipe, sprinkler piping, etc.
2. Include pipe hanger and support locations

C. Electrical

1. Include fire protection equipment power feeds, fire alarm interfaces, etc.

D. Controls

1. Include equipment controller locations, sensor locations, panel locations, power, network wiring, low voltage wiring, etc.

3.5 REQUIRED CONTENT

A. Quantities, dimensions and locations for piping and sprinklers shall be included in the preparation of coordination drawings.

B. Show relation of all items of heating, ventilating and air conditioning equipment, ductwork and piping, plumbing equipment and piping and fire protection equipment and piping. Indicate all electrical devices that affect location of heating, ventilating, air conditioning and plumbing equipment, piping, ductwork and air inlets or outlets. Field measure and show existing items affecting new installation in remodeled areas. Questions and interferences shall be indicated on the coordination drawings for clarification by the Engineer and Architect. If there are not questions and interferences indicated on the coordination drawings, the Engineer and Architect shall assume that the drawings and specifications are complete and correct and will expect the intent of said documents to be complied with, and the installation to be complete in all respects according to said intent.

C. Indicate location of all access panels required and coordinate type and location with General Trades.

D. For Equipment Rooms and areas, coordination drawings shall show, but are not limited to the following:

1. Floor drains and concrete housekeeping pads.
2. All equipment, fire protection work, and work of other trades, including floor supports and ceiling suspension systems showing manufacturers recommend installation requirements.
3. All access areas around all equipment with clearances noted from floor to underside of mechanical and other trades work.
4. All clear floor areas required for removal and cleaning of coils, filters, tubes, etc.

E. Secure from other trades (i.e., mechanical, structural, acoustical ceilings, plumbing, electrical, etc.) any information necessary for the development of coordination drawings. This information shall include, but is not limited to the following:

1. Structural steel and slab layouts and details.
2. Framing and suspension details for ceilings.
3. Framing and suspension details for equipment suspended from structure above.
4. Location and size of electrical pull boxes, conduit, buss ducts, cable trays, lighting fixtures, etc.
5. Location and size of transformers, switchgear, and motor control centers.
6. Pneumatic transport tubes.

F. Provide a coordinated set of wiring diagrams for motors, equipment items and temperature control showing line diagrams, power diagrams and terminal connections to ensure proper operation specified. Include provisions to accommodate equipment that is specified as an acceptable alternative from equipment that is the "Specified Standard" so that, if the acceptable alternative is installed, there will be no change in the Contract Sum.

G. Existing Conditions

1. Any existing pipe or equipment which will impact routing and layout of new work (such as existing standpipes, fire mains and sprinkler piping), shall be field measured by this Contractor and shown on coordination drawings.

3.6 PHASING

A. This project is broken into multiple phases of work. Spaces surrounding phased work areas are to remain occupied during construction. Many of these phases require demolition of and alterations to sprinklers, and fire protection systems within the phased work area that affect surrounding areas outside of the phased work area. Temporary piping to areas outside of each phased work area shall be shown on coordination drawings to allow those areas to remain occupied during construction.

END OF SECTION 21 01 30

SECTION 21 02 10
OWNER OPERATING AND MAINTENANCE TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications complement the requirements of this section.

1.2 SCOPE

A. This section describes the general requirements for the purpose of operations and maintenance training of the Owner's facility personnel on the systems and equipment installed or modified under this project.

B. Provide training to the Owner's designated personnel for all equipment and systems listed herein. Individual specification sections indicate the minimum number of training hours required.

1.3 SUBMITTALS

A. Submit to the Architect a schedule of all training sessions, topics to be covered, times, and attending personnel at least fourteen (14) days prior to the first session.

B. Submit to the Architect a completed copy of the Owner Operations and Maintenance Training form (attachment 21 02 30a) at the completion of each required training session

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 REQUIRED SESSIONS

Table 21 02 10.1

Session Topic	Minimum Hours

3.2

3.3 GENERAL

A. Prior to acceptance of the work and after all equipment is in operation, provide to the Owner instructions for the purpose of training the Owner's personnel in all phases of operation and maintenance of equipment and systems provided under this Division.

B. Contractor shall furnish the necessary trained personnel to perform the demonstrations and instruction, and shall arrange to have the manufacturer's representatives present to assist with the demonstrations where specified.

C. Operation and maintenance manuals shall be provided to the owner at least fourteen (14) days prior to the first training session.

3.4 TRAINING REQUIREMENTS

A. The demonstrations shall consist of not less than the following:

1. Point out the actual location of each component of a system and demonstrate its function and its relationship to other components within the system.
2. Demonstrate each system by actual "start-stop" operation showing how to work controls, how to reset protective devices, how to replace components requiring regular maintenance, and what to do in an emergency.
3. Demonstrate communication, signal, alarm and detection systems by actual operation of the systems and show how to reset signal, alarm and detection devices.

END OF SECTION 21 02 10

SECTION 21 03 10
SYSTEM AND COMPONENT FLUSHING AND TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications complement the requirements of this section.

1.2 SCOPE

A. This Section specifies piping systems' testing and cleaning requirements common to more than one section of Division 21. Portions of this Section may not be required in this project.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all piping testing and cleaning work described in this Section.

1.3 CODES AND STANDARDS

A. All fire protection piping systems shall be flushed and tested in accordance with National Fire Protection Association requirements and Local Building Code requirements.

1.4 CERTIFICATION

A. Refer to Section 210010.

B. After the completion of all required tests and flushing procedures provide Owner with (3) copies of the following:

1. Signed Flushing Certificate.

2. Signed Hydrostatic Pressure Test Certificate.

3. Signed Certificate of Acceptance.

C. Certificates shall be included as part of the Operating and Maintenance Manuals.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 INSPECTIONS

A. Obtain all piping inspections required by the authorities having jurisdiction over premises. Furnish all certificates of such inspections and include in the Operating and Maintenance Manuals. Pay all fees necessary for the inspections.

B. No part of system shall be covered before inspection is made and approved. If covered before test, Contractor shall pay for cost of uncovering so test can be made and accepted.

3.2 GENERAL TESTING REQUIREMENTS

A. Perform piping system pressure tests to all piping systems prior to final connections to existing piping or equipment. If existing piping or equipment is connected, it shall be isolated from the system during the test.

B. Perform all tests before piping is concealed.

C. Contractor is responsible for completely draining the systems after hydrostatic tests are performed. Any damage from freezing prior to acceptance of the completed installation shall be repaired at no additional cost to the Owner.

D. Contractor is responsible for providing all equipment, power and labor necessary for performing all required inspections and tests.

E. Contractor shall complete a copy of the NFPA's Material and Test Certificate and submit it to the Architect for record.

F. Pressure tests shall be witnessed by Owner's representative.

3.3 FLUSHING

A. Flush piping systems prior to testing in accordance with NFPA 13, NFPA 14, and NFPA 24. The volume of water utilized for flushing shall create a minimum velocity of 10 feet per second.

B. Piping between the fire department backfeed connection and the check valve shall be flushed with sufficient water volume in order to remove construction debris and trash accumulated in the piping prior to the completion of the system and prior to the installation of the fire department backfeed connection.

3.4 HYDROSTATIC SYSTEM PRESSURE TEST

A. Tests shall be made with water (hydrostatic), at a required pressure for a set duration, without appreciable pressure drop. The appropriate tests and flushing procedures shall be conducted as the installation progresses, as stipulated by the applicable regulations. Provide all necessary labor and equipment for such tests.

B. Perform hydrostatic system pressure tests as outline below and conforming to all NFPA 13, 14, and 24 requirements for all new systems, including modified existing systems.

C. System pressure shall be measured for the purposes of the hydrostatic system pressure test at the lowest point in each piping system.

D. Test entire new piping systems including standpipes, including underground exterior piping from the connection to the public water system.

E. Test Duration: 2 hours

F. Initial Test Pressure: 200 PSI or 50 PSI in excess of the maximum system pressure where maximum pressure is in excess of 150 PSI.

G. Allowable Pressure Leakage: None, other than that allowed in the underground service entry piping as defined in NPFA 24 "Standard for the Installation of Private Service Mains and Their Appurtenances".

H. Freezing: Any testing that could result in portions of the system being exposed to freezing conditions shall be postponed until such a time that there is no freezing concern. In the interim, an air test shall be performed to verify system integrity. Air test shall be conducted at 40 psi air pressure for a duration of 24 hours.

1. Standpipes:

a. System air pressure leakage shall be 1.5 psi or less over the 24 hour testing period.

I. Pressure Regulating Valves:

1. Where pressure regulating valves are required, verify that the pressure downstream of each pressure regulating device is within required limits.

J. Recorded Data

1. Record pressure at the top of each standpipe utilizing the permanently installed pressure gauges at the beginning of the test period and at the end of the test period.

2. Record pressure downstream of each pressure regulating device.

3.5 SYSTEM DEMAND VERIFICATION TEST

A. Perform system demand verification tests as outlined below and conforming to all NFPA 13, 14, and 24 requirements for all new systems, and modified existing systems.

B. Standpipes:

1. The standpipe system shall be tested to verify system demand per NFPA 14.

3.6 MAIN DRAIN FLOW TEST

A. The contractor shall open the main drain valve and flow the system until the pressure stabilizes.

3.7 ALARM DEVICE TESTS

A. Waterflow detecting devices including associated alarm circuits shall be flow tested through the inspector's test connection and shall result in an alarm to the fire alarm system/

B. Manual shut-off valves utilizing electronic "tamper" devices shall be fully closed to verify that and alarm is generated to the fire alarm system upon valve closure. The valve shall be fully opened when testing is complete.

3.8 BACKFLOW PREVENTION ASSEMBLIES

A. The backflow prevention assembly shall be forward flow tested to ensure proper operation.

B. The minimum flow rate shall be the system demand, including hose stream allowance where applicable.

3.9 PROTECTION

A. Protect systems prone to freezing during required tests

3.10 CORRECTIONS

A. Should any system not meet the specified requirements of any required test, drain the system and make necessary corrections to remediate the source of the test failure.

B. Correct minor leaks in welded joints by chipping out weld and re-welding.

C. Correct leaks in screwed joints by replacing thread or fitting or both. Caulking of threaded joints is not permitted.

D. Correct leaks in groove piping by replacing gaskets and re-grooving pipe if necessary.

3.11 RETEST

A. Retest any systems not meeting specified standards during the original test, after corrections have been made to remediate the source of the test failure.

END OF SECTION 21 03 10

SECTION 21 03 20
FIRE PUMP TESTING

PART 1 - GENERAL

1.1 SCOPE

A. This Section specifies fire pump testing requirements.

B. Provide all materials, equipment, labor and supervision necessary to install and perform fire pump testing work described in this Section.

1.2 CODES AND STANDARDS

A. All fire pumps shall be tested in accordance with National Fire Protection Association NFPA 20 requirements.

1.3 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 21 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 21 04 40.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Perform the following tests for each installed fire pump or jockey pump

B. All tests shall be in accordance with NFPA 20 test procedures

3.2 GENERAL TESTING REQUIREMENTS

A. Perform fire pump performance tests to each fire or jockey pump once all equipment and system piping is in place and after system piping has been tested in accordance with other sections of this Division.

3.3 TESTING EQUIPMENT

A. The test equipment shall be provided by this Division 21 contractor, unless the authority having jurisdiction agrees to supply the testing equipment ahead of time.

B. Equipment for Use with Fire Pump Test Header:

1. 50 ft lengths of 2-1/2" lined hose shall be provided in including Underwriter Laboratories' play pipe nozzles as needed to flow required volume of water. Where test meter is provided, these may not be required.

C. Instrumentation:

1. Clamp-on volt/ammeter
2. Test gauges
3. Tachometer
4. Pitot tube with gauge (for use with hose and nozzle)

D. Instrumentation Calibration:

1. All test instrumentation should be calibrated by an approved testing and calibration facility within 12 months prior to the test. Calibration documentation should be available for review by the authority having jurisdiction.

3.4 TEST PROCEDURE

A. The testing procedure shall be as outlined in NFPA 20, and as required by the local authority having jurisdiction.

B. Contractor is responsible for providing all equipment, power and labor necessary for performing all required inspections and tests.

3.5 CORRECTIONS

A. Should the initial pump test not meet required performance as scheduled and per NFPA 20, correct deficient installations.

B. Correct minor leaks in welded joints by chipping out weld and re-welding.

C. Correct leaks in screwed joints by replacing thread or fitting or both. Caulking of threaded joints is not permitted.

D. Correct leaks in groove piping by replacing gaskets and re-grooving pipe if necessary.

3.6 RETEST

A. Retest pump(s) per the procedure outlined above and per NFPA 20 until required performance is achieved.

END OF SECTION 21 03 20

SECTION 21 04 20
PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE

A. This Section specifies painting requirements for this division and includes descriptions of piping and systems included as part of this division's contract and general application methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

C. Finishing (paint, wall covering, etc.) shall not be included under this Section.

PART 2 - PRODUCTS

2.1 GENERAL

A. All painted metal surface shall be primed and painted with an oil based paint. Apply painting to the following areas utilizing Sherwin-Williams Materials:

1. Ferrous Metal (Exterior): One coat Galvite HS and two coats All Surface Alkyd Enamel.

2. Ferrous Metals (Interior): Spot prime abraded areas with All Surface Enamel Primer and two coats ProClassic Alkyd Interior Enamel.

3. Insulated Coverings: One coat Fast Drying Primer and two coats ProMar 400 Alkyd Semi-Gloss.

B. Where colors are indicated to match adjacent building finish, the Architect/Engineer shall make final color seleciton.

C. Equipment touch up painting shall match the equipment finish.

D. See Part 3 – Execution for piping, supports and equipment to be painted.

2.2 ACCEPTABLE MANUFACTURERS

A. Painting shall be done with products as manufactured by Pittsburgh Plate Glass, Sherwin-Williams, Pratt, Lambert and Glidden.

PART 3 - EXECUTION

3.1 LOCATIONS REQUIRING PAINTING

A. All fire piping serving standpipes, both exposed and concealed above ceilings shall be painted red, unless specifically indicated otherwise on the drawings.

B. Exposed iron work, hangers, pipe, equipment casings or enclosures, and tanks exterior to mechanical equipment rooms.

1. "Exposed" shall refer to exposed to view and shall not include piping or materials concealed above ceilings, under floor slabs, or buried in walls.

3.2 GENERAL:

A. Where equipment is complete with a factory finish, additional painting is not required unless directed by the Engineer (requiring a color change).

B. No equipment or piping shall be painted before being tested.

C. Damaged surfaces of prefinished materials and equipment shall be touch-up painted to match existing finish.

D. Do not paint over name plates, labels, identification tags, signs, markers, etc.

3.3 PRE-PAINTING PREPARATION

A. Materials and equipment installed under this Division shall be left free from dirt, grease and foreign matter, ready for painting.

B. Comply with manufacturer's recommendations for mixing and application.

3.4 FIELD QUALITY CONTROL

A. Provide protective drop coverings for all permanent finishes and surfaces while applying paint and until the final coating has dried to protect from excess paint spills, drips, etc.

3.5 CLEANING

A. Clean excess paint from any surfaces not meant to be painted.

B. Remove protective coverings once final paint coat has dried.

END OF SECTION 21 04 20

SECTION 21 04 40
EQUIPMENT PADS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The other Specs of this Division complement the requirements of this Section.

1.2 SCOPE

A. This section describes the acceptable materials and installation methods to provide housekeeping pads, curbs, rails, inertia bases, etc., for equipment furnished under this Division.

B. Furnish all equipment, materials, labor, and supervision necessary to provide cast-in-place concrete housekeeping pads, curbs, rails, inertia bases, etc., as described herein and where indicated on the drawings. Extent of mechanical related work required by this Section is indicated on the drawings.

1.3 QUALITY ASSURANCE

A. Concrete Work Codes and Standards: Comply with governing regulations and, where not otherwise indicated, comply with industry standard in its application to work in each instance.

1. ACI 301 "Specifications for Structural Concrete Buildings."

2. ACI 381 "Building Code Requirements for Reinforced Concrete."

3. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice."

1.4 SUBMITTALS

A. Shop Drawings

1. Provide Shop Drawings, per requirements of Section 21 01 10.

B. Operation and Maintenance (O&M) Manuals

1. Provide manuals, per requirements of Section 21 01 10.

C. Product Data

1. For each type of mixture provided.

D. Design Mixtures

1. For each concrete mixture, submit alternate design mixtures when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 PROJECT CONDITIONS

A. Protect adjacent finish materials against spatter during concrete placement.

PART 2 - PRODUCTS (NOT APPLICABLE)

2.1 CONCRETE RELATED MATERIALS

A. Forms for exposed finish concrete work shall be of lumber, metal, metal-framed or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces.

1. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

2. Welded Wire Reinforcing Fabric: ASTM A 185, welded steel wire fabric.

3. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place.

2.2 CONCRETE MATERIALS

A. Materials for concrete work shall comply with requirements of other Divisions "Portland Cement Concrete Paving" Section.

B. Portland Cement: ASTM C 150, Type I.

C. Use one brand of cement throughout project, unless otherwise acceptable to Architect. Prepare design mixes for each strength of concrete indicated.

1. Fly Ash: ASTM C 618, Type C or Type F.

2. Fine Aggregate: ASTM C 33, sand.

3. Course Aggregate: ASTM C 33, crushed gravel.

2.3 DESIGN AND PROPORTIONING OF CONCRETE MIXES

A. General: Design mechanical work concrete as follows, for each 28-day compressive strength class:

1. 3000 psi Class: 500lbs. of cement per cu. Yard (5.25 sacks) and 0.46 water/cement ratio.

PART 3 - EXECUTION

3.1 INSTALLATION OF CONCRETE

A. Formwork:

1. General: Design, construct, support, brace, and maintain formwork to support vertical and lateral, static and dynamic loads that might be applied until such loads can be supported by concrete structure. Construct formwork so that formed concrete will be of required size, shape, alignment, elevation, and position.

a. Construct forms to retain equipment anchor bolts in accurate locations during placement of reinforcing steel and concrete. Use templates furnished by equipment manufacturers, to locate anchor bolts, or where not furnished, locate by accurate measure from certified setting diagrams.

B. Placing Reinforcement:

1. General: Comply with requirements and recommendations of specified standards, including "Placing Reinforcing Bars" by CRSI's "Manual of Standard Practice."

C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces.

D. Chamfer exposed corners and edges using wood, metal, PVC or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

E. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support built into forms.

F. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed. Re-tightening forms and bracing after concrete placement is required to eliminate mortar leaks and maintain proper alignment. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials which would reduce bond with concrete.

G. Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.

H. Place reinforcement to obtain at least minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

I. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.

3.2 PREPARATION OF FORM SURFACES

A. Clean re-used forms of concrete matrix residue, repair and patch as required to return forms to acceptable surface condition.

B. Coat contact surfaces of forms with a form-coating compound before reinforcement is placed.

C. Thin form-coating compounds only with thinning agent of type, amount, and under conditions of form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.

D. Coat steel forms with a non-staining, rust preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

3.3 REMOVAL OF FORMS

A. Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50°(10°) for 24 hours after placing concrete, provided concrete sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.

3.4 CONCRETE PLACEMENT

A. Pre-placement inspection: Before placing, inspect and complete formwork installation, reinforcement steel, and items to be embedded or cast-in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where coatings are bot used.

B. General: Comply with ACI 304 "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete", and as herein specified.

C. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation.

D. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.

E. Placing Concrete Slabs: Deposit and consolidate slabs in a continuous operation within limits of construction joints, until the placing of a panel or section is completed.

F. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.

G. Bring slab surfaces to correct level with straightedge and strike-off. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.

H. Maintain reinforcing in proper position during concrete placement operations.

3.5 CONCRETE CURING AND PROTECTION

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting; keep continuously moist for not less than 7 days.

C. Begin final curing procedures immediately initial curing and before concrete has dried. Continue final curing for at least 7 days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.

1. Cold Weather Placement: Comply with ACI 306. Do not use frozen materials or materials containing ice and snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. When air temperature has fallen or is expected to fall below 40°F (4.4°C), heat water and aggregates uniformly before mixing, as required to obtain concrete mixture temperature of not less than 50°F (10°C), and not more than 80°F (26.7°C), at time of placement. Protect concrete work from physical damage and reduced strength resulting from frost, freezing actions, or low temperatures.

2. Finishing Horizontal Surfaces: Float and trowel horizontal (top) surfaces to level, smooth, uniform textured, dense finish, where surface is to remain exposed or receive coating, membrane or other thin-set finish. Otherwise, leave struck-off surface undisturbed, except scratch surfaces which are to receive concrete or mortar topping or setting bed, by ranking with a stiff broom.

3.6 MISCELLANEOUS CONCRETE ITEMS

A. Curbs: Provide monolithic finish on interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to hard, dense finish with corners, intersections and terminations slightly rounded and coved.

B. Equipment Bases and Foundation: Provide equipment bases and foundations, as shown on drawings. Set anchor bolts for equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing equipment.

C. In the absence of more specific information, either on the drawings, or in manufacturer's literature, concrete bases shall be level, shall have a minimum height above finished floor of 4" and extend 3" beyond the skids, feet or bed plate of the item of equipment.

D. Concrete pads, pedestals, or saddles placed in existing structures shall be mounted securely to the original substrate with anchor bolts.

E. Grout base plates and foundation as indicated, using non-shrink grout. Use non-metallic grout for exposed conditions.

3.7 CONCRETE SURFACE REPAIRS

A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Architect.

B. Cut out honeycomb, rock pockets, voids over ¼" in any dimension, and holes left by tie rods, and bolts, down to solid concrete but, in no case to a depth of less than 1 qt. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with bonding agent. Place patching mortar after bonding compound has dried.

1. Unexposed Surfaces: Repair significantly damaged and honeycombed areas, and remove major projections and fins where forms have been removed.

2. Exposed Surfaces: On formed which are to be exposed, including those to be coated or covered with membrane or other thin-set applied finish, repair and patch form-tie holes and damaged and honeycombed areas, filling voids with gout and completely removing fins and other projections.

3.8 DELIVERY, STORAGE, HANDLING

A. Deliver, store, and handle steel reinforcement to prevent bending and damage.

3.9 CLEANING

A. Clean area after pad has cured of left-over or spilled concrete, dust, or other materials on-site to facilitate concrete mixing and pouring.

END OF SECTION 21 04 40

SECTION 21 05 10
ELECTRICAL REQUIREMENTS FOR FIRE PROTECTION EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications complement the requirements of this Section. Separate electrical components and materials for field installation and electrical connections are specified in Division 26.

1.2 SCOPE

A. This Section specifies basic requirements for electrical components which are an integral part of packaged fire protection equipment. These components include, but are not limited to factory installed motors, starters, and disconnect switches furnished as an integral part of packaged fire protection equipment.

B. Provide all materials, equipment, labor and supervision necessary to install all electrical components and devices described in this Section.

C. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings or described in other Sections of Division 21.

D. All field wiring of components and devices described in this Section shall be by the Electrical Contractor as specified in Division 26.

1.3 CODES AND STANDARDS

A. All motors, electrical devices and enclosures shall comply with NEMA and IEEE Standards for the specific application in which installed.

B. Electrical components and integral wiring shall comply with the National Electrical Code (NFPA 70).

C. Electrical components and materials shall be UL labeled.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide motors as manufactured by one of the following:

1. AO Smith
2. Baldor
3. Emerson
4. General Electric
5. Leeson
6. Louis Allis
7. Marathon
8. Teco
9. Westinghouse

2.2 GENERAL

A. All fire protection equipment control panel and electrical device enclosure covers shall be provided with defeatable interlocks to permit opening of panel (by qualified personnel) while equipment is in operation.

B. Fabricate fire protection equipment for secure mounting of motors and other electrical items integral with the equipment. Provide either permanent alignment of motors with equipment or adjustable mountings as applicable for belt drives, gear drives, special couplings and similar indirect coupling of equipment. Provide safe, secure, durable, and removable guards for motor drives, arranged for lubrication and similar running-maintenance without removal of guards. Guards shall include opening for insertion of revolution counter at motor drive sheave.

2.3 MOTORS

A. For each item of equipment requiring electric drive, provide an induction motor having starting and running characteristics consistent with the torque and speed requirements of the driven equipment. In no case shall power requirements of the driven equipment exceed the nominal nameplate rating of the furnished motor (do not take advantage of service factors in selecting motors). For design, construction and performance characteristics conform to applicable provisions of latest NEMA and IEEE standards for rotating electrical equipment.

B. Unless otherwise specified, motors are to be general-purpose open-drip proof type, nominal 1800 RPM with Class B insulation, rated for continuous operation in 40°C ambient temperature. All motors utilized with variable frequency drives shall be "inverter ready" motors with class F insulation in accordance with NEMA MG1 Part 31.4.4.2.

1. Unless otherwise scheduled on the drawings, motors 1/2 HP and smaller shall be single phase, capacitor start type, with ball bearings. Shaded-pole type with sleeve bearings are acceptable only for motors less than 1/16 HP.

2. Unless otherwise scheduled on the drawings, motors 3/4 HP and larger shall be three phase, squirrel-cage type with ball bearings.

3. Ball bearings shall be regreasable, except where motor is normally inaccessible for regular maintenance, permanently sealed ball bearings shall be provided.

C. Motors shall have a minimum efficiency in accordance with IEEE Standard 112, test method B. If horsepower is not listed, motors shall have a higher efficiency than "average standard industry motors" in accordance with IEEE Standard 112, test method B.

D. Motors shall be furnished with stainless steel nameplate indicating manufacturer, ratings, characteristics, construction, efficiency and special features.

2.4 MANUAL MOTOR STARTERS

A. In general, single phase motors shall be equipped with manual motor starters. Manual motor starters shall be provided and installed by the electrical contractor as specified in Division 26 unless noted otherwise on the Division 21 drawings or in the Division 21 specifications.

B. Enclosures in dry indoor locations shall be general purpose NEMA Type 1, unless noted otherwise. Enclosures in wet indoor or outdoor locations shall be NEMA Type 4 (stainless steel, unless noted otherwise).

C. Manual motor starter shall include neon pilot light, "Quick-make, quick-break" trip-free toggle mechanism and melting alloy thermal overload relay sized to protect the motor.

2.5 COMBINATION MOTOR STARTERS

A. In general, three phase motors shall be equipped with combination motor starters. Combination motor starters shall be provided and installed by the electrical contractor as specified in Division 26 unless noted otherwise on the Division 21 drawings or in the Division 21 specifications.

B. Enclosures in dry indoor locations shall be general purpose NEMA Type 1, unless noted otherwise. Enclosures in wet indoor or outdoor locations shall be NEMA Type 4 (stainless steel, unless noted otherwise).

C. Size of starters shall be as recommended by the motor or driven equipment manufacturer.

D. Combination motor starters shall include a disconnect as specified in the following section "2.5 Disconnect Switches". Starter shall be furnished with the following devices:

1. "HAND-OFF-AUTO" selector switch in cover.

2. Heavy duty push-to-test red pilot light to illuminate when motor is running.

3. Control power transformer (coordinate secondary voltage with required control voltage). Control transformer primary shall be connected to the load side of the incoming line disconnect fuses and the secondary shall be fused and grounded.

4. Three (3) bi-metal type thermal overload elements. The starter shall be inoperative if any thermal element is removed.

5. Minimum of two NO/NC field convertible auxiliary contacts. Two NO and two NC contacts may be furnished in lieu of convertible contacts.

6. Engraved nameplate on the door describing the equipment controlled.

2.6 DISCONNECT SWITCHES

A. Disconnect switches shall be provided and installed by the electrical contractor as specified in Division 26 unless noted otherwise on the Division 21 drawings or in the Division 21 specifications.

B. In dry indoor locations, enclosures shall be general purpose NEMA Type 1, unless noted otherwise. In wet indoor or outdoor locations enclosures shall be NEMA Type 4 (stainless steel), unless noted otherwise.

C. Size of disconnect switches shall be as recommended by the motor or driven equipment manufacturer.

D. Disconnect switches shall be fusible type, with Class R rejection fuse clips.

1. The disconnect handle shall always be in control of the disconnect device with the door open or closed. The disconnect handle shall be clearly marked as to whether the disconnect device is "ON" or "OFF", and shall include a two-color handle grip, the black side visible in the "OFF" position indicating a safe condition, and the red side visible in the "ON" position indicating a dangerous condition.

2. Disconnect handle shall contain provisions for padlocking in the "OFF" position.

3. If required, the disconnect switch shall be furnished with one auxiliary SPDT contact for use by the Temperature Control Contractor to de-energize remotely powered interlock wiring when the disconnect is in the "OFF" position.

E. Disconnect switches shall be furnished with a ground lug.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Install motors on motor mounting systems in accordance with motor manufacturer's instructions, securely anchored to resist torque, drive thrusts, and other external forces inherent in mechanical work. Secure sheaves and other drive units to motor shafts with keys and Allen set screws, except motors of 1/3 HP and less may be secured with Allen set screws on flat surface of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.

B. Install starters and wiring devices at location indicated, securely supported and anchored, and in accordance with manufacturer's installation instructions. Locate for proper operational access, including visibility, and for safety.

C. Install power and control connections for motors to comply with NEC and applicable provision of Division 26 sections. Install grounding except where non-grounded isolation of motor is indicated.

D. Prior to the purchase or installation of any equipment, verify all motor voltage characteristics with the Electrical Contractor.

E. Make final electrical connection to all motors with flexible metal conduit unless plug-in electrical cords are specified. Line voltage terminations shall be by the Electrical Contractor.

END OF SECTION 21 05 10

SECTION 21 07 10
PENETRATIONS AND SLEEVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section specifies basic requirements for walls and floor penetrations.

B. Furnish all equipment, materials, labor, and supervision necessary to make all required mechanical penetrations as described herein.

1.3 CODES AND STANDARDS

A. Underwriters' Laboratory (UL)

B. ASTM E-84 (NFPA 255)

1.4 SUBMITTALS

A. Slab-on-grade floors and below-grade wall penetration seal: Submit manufacturer's cutsheet(s), including dimensions, materials, installation recommendations, ratings and code compliance information, etc.

B. Shop Drawings:

1. Provide, per requirements of Section 21 01 10.

PART 2 - PRODUCTS

2.1 BELOW-GRADE WALL AND SLAB-ON-GRADE FLOOR PENETRATION SEALS

A. Mechanical seals shall consist of intumescent synthetic rubber plugs, plastic or stainless steel pressure plates, and stainless steel bolts.

B. Subject to compliance with requirements, provide below-grade wall and floor slab penetration seals as manufactured by one of the following:

1. Metra-Flex
2. Thunderline Corp

2.2 PIPE SLEEVE MATERIALS

A. Schedule 40 black steel pipe.

2.3 SOUND STOPPING

A. Fiberglass insulation, 2 lb density.

B. Material shall be non-asbestos and non-friable.

C. Provide all insulation materials with a flame-spread index of 25 or less and smoke developed index of 50 or less, as tested under procedure ASTM E-84 (NFPA 255).

2.4 ESCUTCHEONS

A. Escutcheons shall be two-piece, chrome-plated brass.

PART 3 - EXECUTION

3.1 GENERAL

A. Pipe sleeves are required at all pipes penetrating concrete walls, masonry walls, fire walls and smoke barrier walls.

B. Where concrete or masonry walls are core drilled for pipe passage, steel sleeves are not required.

C. Where concrete floor slabs or concrete roof slabs are core drilled for pipe passage, steel sleeves are not required – except in mechanical rooms and all rooms containing water piping.

D. In new concrete walls, floors, and roofs, coordinate the exact locations of pipe sleeves with the General Trades Contractor performing this work prior to concrete pour.

E. Each Contractor is responsible to furnish and install his own pipe sleeves.

3.2 CUTTING AND PATCHING

A. This Contractor shall provide all penetrations in new and existing construction required for the installation of fire protection piping, conduit, and equipment. Do not cut any structural member without specific permission from the Architect.

B. Penetrations shall be cut as small as practical with as little damage as possible and in a manner satisfactory to the Architect.

C. The Fire Protection Contractor shall seal all penetrations and repair all damage caused by the installation and/or removal of a fire protection system they install. All materials shall be new and shall match the adjacent construction.

D. Finishes (paint, wall covering, etc.) shall not be included under this Section.

3.3 MASONRY OR CONCRETE WALL BELOW-GRADE AND FLOOR SLABS ON-GRADE:

A. Sleeves shall be one inch (1") larger than the outside diameter of the pipe including insulation where applicable, or two pipe sizes larger, whichever is bigger.

B. Set pipe wall sleeves with ends of sleeves flush with wall faces. Set pipe floor sleeves with top of sleeve 4 inches above finished floor in water entry rooms, mechanical rooms and wet floor locations.

C. Center pipes in sleeves.

D. Provide below-grade mechanical wall and floor penetration seals to fill the annular space between the pipe outside wall and the sleeve inside wall. Center wall penetration seal within the wall. Comply with wall and floor penetration seal manufacturer's installation instructions.

3.4 MASONRY OR CONCRETE WALL ABOVE-GRADE

A. Sleeves shall be one inch (1") larger than the outside diameter of the pipe including insulation where applicable, or two pipe sizes larger, whichever is bigger.

B. Set pipe sleeves with ends of sleeves flush with wall faces.

C. Center pipes in sleeves.

D. For fire or smoke rated walls, fill the annular space between the pipe and the sleeve with the proper firestopping material. See "Firestopping" specification section, this Division for products and installation methods.

E. For unrated walls, fill the annular space between the pipe and the sleeve with sound stopping.

3.5 CONCRETE FLOOR OR ROOF:

A. Sleeves 1 inch larger than the outside diameter of the pipe, or two pipe sizes larger, whichever is bigger.

B. Set pipe sleeves with top of sleeve flush with roof slab or deck surface.

C. Set pipe floor sleeves with top of sleeve to be 4 inches above finished floor in water entry rooms, mechanical rooms and wet floor locations.

D. Center pipes in sleeves.

E. For fire or smoke rated floors and roofs, fill the annular space between the pipe and the sleeve with the proper firestopping material. See "Firestopping" specification section, this Division for products and installation methods.

F. For unrated floors and roofs, fill the annular space between the pipe and the sleeve with sound stopping.

3.6 FIRE OR SMOKE RATED WALL:

A. Sleeves 1 inch larger than the outside diameter of the pipe, or two pipe sizes larger, whichever is bigger.

B. Set pipe sleeves flush with wall surface.

C. Center pipes in sleeves.

D. For fire or smoke rated walls, fill the annular space between the pipe and the sleeve with the proper firestopping material. See "Firestopping" specification section, this Division for products and installation methods.

3.7 SOUND STOPPING

A. Where pipes or other components of Division 21 work pass through non-fire rated walls, provide sound stopping between such work and the wall material intended to reduce the transmission of sound from on side of the wall to the other.

B. Sound stopping of pipes in sleeves shall consist of sealing the outside of the sleeve with caulking and the inside with an insulating material.

C. Sound stopping of pipes without sleeves shall consist of packing the cavity around the penetration with an insulating material and sealing the opening with approved sealant or plaster.

D. Insulating materials shall be non-asbestos and non-friable, and shall have a flame spread rating of no more than 25 and a smoke developed rating of no more than 50.

3.8 ESCUTCHEONS

A. Fit all pipe passing exposed through walls, floors, or ceilings in finished rooms with escutcheons. Where adjacent surface is to receive a paint finish, prime paint escutcheons, otherwise escutcheons shall be chrome plated.

END OF SECTION 21 07 10

SECTION 21 07 20
FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section specifies firestopping materials and installation requirements for the penetration of rated assemblies. Portions of this Section may not be required in this project. Actual field conditions, penetration type (pipe, conduit, etc.) and assembly type, shall define exact firestopping requirements.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 QUALITY ASSURANCE

A. The firestop system installation shall be UL Listed and tested in accordance with ASTM E814.

B. Fire rating of the firestop system shall be equivalent to the assembly which is penetrated.

C. The final installation shall meet the requirements of the Local Building Code and other applicable building codes and regulations.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 21 01 10.

PART 2 - PRODUCTS

2.1 ACCEPTABLE PRODUCTS

A. Hilti “FS-One”

B. Nelson “Flameseal"

C. Specified Technologies Inc. “Spec Seal”

D. International Protective Coatings “Flamesafe"

E. 3M

F. Rector Seal

G. Metacaulk

2.2 PIPE AND CONDUIT PENETRATION PROTECTION

A. All products used under this Section shall be UL listed for the purpose.

B. Fire barrier products shall be installed in accordance with all U.L. System requirements for the type of penetration and firestopping system used. The following U.L. System descriptions are those of Hilti Inc. firestopping systems.

1. Pipe Penetration Table:

Penetration	Rating	U.L. System
Metal Pipe Through Gypsum Board	1 or 2 hour	Hilti UL #WL1054 or Approved Equal
Metal Pipe Through Masonry/Concrete	2 hour	Hilti UL #CAJ1291 or Approved Equal
Metal Pipe Through Masonry/Concrete	3 hour	Hilti UL #CAJ1155 OR #CAJ1226 or Approved Equal
Metal Pipe Through Poured Concrete Floor Slab	3 hour	Hilti UL #FA1017 or Approved Equal
Plastic pipe through gypsum board	1 or 2 hour	Hilti UL #WL2078 or Approved equal
Plastic pipe through masonry/concrete	2 hour	Hilti UL #CAJ2271 or Approved equal
Plastic pipe through poured concrete floor slab	3 hour	Hilti UL#FA2054 or Approved equal

2. Actual project conditions may require a UL System not specifically described above. Fire barrier products manufacturer shall provide a UL System to meet actual project conditions.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. All penetrations (pipe, conduit, etc.) through fire rated assemblies shall be firestopped.

B. All firestopping materials shall be installed per the manufacturer's instructions.

C. Examine the areas and conditions where firestops are to be installed and notify the Architect of conditions detrimental to the proper and timely completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected by the contractor in a manner acceptable to the Architect.

D. Unused sleeves or core drilled holes shall be plugged with fire resistant material and finished to match adjacent surfaces.

E. Finish surfaces of firestopping, which are to remain exposed to view, to a uniform and level condition.

3.2 FIELD QUALITY CONTROL

A. All areas of work must be accessible until notification and inspection by the applicable Code authorities.

B. Have firestops examined by proper authorities to ensure proper installation and full compliance with this specification. If required, show proof of compliance by providing the appropriate UL firestopping system number.

C. Correct unacceptable firestops and provide additional inspection to verify compliance with this specification at no additional cost.

END OF SECTION 21 07 20

SECTION 21 09 10
HYDRAULIC DESIGN REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies the requirements for sprinkler system hydraulic calculations performed for the design and layout of the fire sprinkler system.

B. In general, fire protection work for this project shall consist of new wet pipe sprinkler systems, new standpipes and a new fire pump.

C. A new fire line with a wall indicator valve, double detector check valve assembly and fire department connection shall be included.

1.3 SYSTEM DESCRIPTION

A. Standpipes

1. Automatic: Wet-Type, Class I Standpipe System: Includes NPS 2-1/2 hose connections. Has open water-supply valve with pressure maintained and is capable of supplying water demand.

2. Automatic: Wet-Type, Class II Standpipe System: Includes NPS 1-1/2 hose stations. Has open water-supply valve with pressure maintained and is capable of supplying water demand.

3. Automatic: Wet-Type, Class III Standpipe System: Includes NPS 1-1/2 hose stations and NPS-2-1/2 (DN 65) hose connections. Has open water-supply valve with pressure maintained and is capable of supplying water demand.

4. Automatic: Dry-Type, Class I Standpipe System: Includes NPS 2-1/2 hose connections. Has open water-supply valve and dry-pipe valve with standpipes containing compressed air. Opening fire-hose valve releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into standpipes.

5. Automatic: Dry-Type, Class II Standpipe System: Includes NPS 1-1/2 hose connections. Has open water-supply valve and dry-pipe valve with standpipes containing compressed air. Opening fire-hose valve releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into standpipes.

6. Automatic: Dry-Type, Class II Standpipe System: Includes NPS 1-1/2 hose connections. Has open water-supply valve and dry-pipe valve with standpipes containing compressed air. Opening fire-hose valve releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into standpipes.

7. Semiautomatic: Dry-Type, Class II Standpipe System: Includes NPS 2-1/2 hose stations. Has open water-supply valve and deluge valve with standpipes containing air. Actuation of detection device permits water pressure to open deluge valve. Water then flows into standpipes.

8. Semiautomatic: Dry-Type, Class II Standpipe System: Includes NPS 1-1/2 hose stations. Has open water-supply valve and deluge valve with standpipes containing air. Actuation of detection device permits water pressure to open deluge valve. Water then flows into standpipes.

9. Semiautomatic: Dry-Type, Class III Standpipe System: Includes NPS 1-1/2 hose stations and NPS 2-1/2 (DN 65) hose connections. Has open water-supply valve and deluge valve with standpipes containing air. Actuation of detection device permits water pressure to open deluge valve. Water then flows into standpipes.
10. Manual Wet-Type, Class I Standpipe System: Includes NPS 2-1/2 hose connections. Has small water supply to maintain water in standpipes. Piping is wet, but water must be pumped into standpipes to satisfy demand.
11. Manual Dry-Type, Class I Standpipe System: Includes NPS 2-1/2 hose connections. Does not have permanent water supply. Piping is dry. Water must be pumped into standpipes to satisfy demand.

B. Sprinkler

1. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.
2. Dry-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing compressed air. Opening of sprinklers releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into piping and discharges from opened sprinklers.
3. Preaction Sprinkler System: Automatic sprinklers are attached to piping containing air. Actuation of fire-detection system in same area as sprinklers opens valve. Water flows into piping and to discharge from sprinklers that have opened.
4. Deluge Sprinkler System: Open sprinklers are attached to piping connected to water supply through deluge valve. Fire-detection system in same area as sprinklers opens valve. Water flows into piping system and discharges from attached sprinklers when valve opens.

C. Combined Systems

1. Combined Standpipe and Sprinkler System: Fire-suppression system with both standpipe and sprinkler systems. Sprinkler system is supplied from standpipe system.
2. Combined Dry-Pipe and Preaction Sprinkler System: Automatic sprinklers are attached to piping containing compressed air. Fire-detection system in same area as sprinklers actuates tripping devices that open dry-pipe valve without loss of air pressure and actuates fire alarm. Water discharges from sprinklers that have opened.

1.4 CODES AND STANDARDS

A. The fire protection system shall be designed and installed per the requirements of the National Fire Protection Association (NFPA), the Owner's insurance carrier and the local authorities having jurisdiction.

1.5 GENERAL DESIGN REQUIREMENTS

A. Design system and prepare the fire protection drawings and hydraulic calculations under direct supervision of a state certified sprinkler designer.

B. The Contract Drawings indicate the general routing of the fire protection system mains. The Fire Protection (FP) Contractor shall layout the sprinkler piping system indicating head locations and exact pipe routing. Sprinkler heads in lay-in ceilings shall be centered in the ceiling tile. For coordination and aesthetic purposes, suggested sprinkler pipe routing and head layouts are shown for selected areas. Refer to the Architectural reflected ceiling plans.

C. Attention is called to the limited space available for the installation of fire protection services. It is essential for the coordination of all trades, that the FP Contractor is responsible for confirming the location and elevations of all piping and equipment at the job site to avoid encroaching upon the space needed and allocated for another trade.

D. General performance requirements

1. Standard Piping System Component Working Pressure: Listed for at least 175 psig.

2. High-Pressure Piping System Component Working Pressure: Listed for 250 psig minimum.

E. Drawings are not intended to be scaled for roughing in measurement or to serve as shop drawings, installation drawings or sleeve drawings. "Working Plans" for these purposes shall be prepared by the FP Contractor.

F. Unless indicated otherwise, conceal all piping in areas with suspended or drywall ceilings.

1.6 SPRINKLER SYSTEM DESIGN REQUIREMENTS

A. Automatic sprinkler piping systems shall be hydraulically designed by the Contractor's certified Designer in accordance with NFPA-13 and the Owner's insurance requirements. Spacing, location and position of sprinklers and piping configuration shall be in strict conformance with the above requirements.

B. Water Supply

1. Flow Data: This Contractor shall establish actual availability of water by conducting a fire flow test along the water line being tapped to serve the building. The water supply flow data shall be measured by the Water Department. The hydraulic calculations for each system shall be taken back to the location of the test.

2. If the Owner has had a test performed within the last year and NO modifications have been made to the piping in the building or the municipal supply outside the building since the test was performed, this Contractor shall be permitted to forego performing a test and utilize these test results for system design calculations.

3. Discharge from the existing building fire pump shall be utilized to sprinkle all remodeled areas.

4. This Contractor shall perform a fire pump test prior to system design to establish water supply performance capabilities to be utilized in calculations. Submit test results and date of test with calculation shop drawings.

C. Hydraulic calculations shall be based upon the following Hazard Occupancy Classifications:

1. Storage and Utility Areas - Ordinary Hazard Group 2.

2. Mechanical and Electrical Rooms - Ordinary Hazard Group 2.

3. Data Processing and Equipment Rooms – Ordinary Hazard Group 2.

4. Offices, restrooms, corridors, and all other areas – Light Hazard.

D. Minimum Density for Automatic-Sprinkler Piping Design:

1. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.

2. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.

3. Ordinary-Hazard, Group 1 Occupancy: 0.20 gpm over 1500-sq.ft. area.

4. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq.ft area.

5. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq.ft. area.

E. The sprinkler system shall be hydraulically balanced to provide the required minimum density over any area, including the most hydraulically remote area.

F. Calculations shall include the sprinkler system demand and hose stream requirements if applicable.

G. The hydraulic calculations shall be based on the Hazen-Williams Formula with a "C" factor of 140 for underground piping and 120 for overhead piping.

H. A riser nameplate shall be permanently affixed to each calculated system riser, providing hydraulic data in accordance with NFPA requirements.

I. If government agencies having jurisdiction and the Owner's insurance underwriter do not require hydraulic calculations on small fire protection renovation projects it should be clearly stated on the fire protection system shop drawings. Where hydraulic calculations are not completed, the alternate pipe sizing method should be clearly stated on the fire protection system shop drawings.

J. Factor of Safety: Provide a 10% factor of safety in all hydraulic calculations as required by local fire department but in no case less than 5 psi minimum. No sprinkler pipe shall be sized for a velocity greater than 20 feet per second.

K. Certificate of Installation: Submit certificate upon completion of fire protection piping work which indicates that work has been tested in accordance with NFPA 13 and also that system is operational, complete and has no defects.

1.7 STANDPIPE DESIGN REQUIREMENTS

A. Standpipes shall be Hydraulically designed by the Contractor’s certified designer in accordance with NFPA-14 and the Owner’s Insurance Requirements.

B. Classifications:

1. Standpipes shall be designed as Class I automatic wet type with 2 ½” fire department connections.

C. System Performance Requirements

1. Minimum residual pressure at each hose-connection outlet is the following:

a. NPS 1-1/2 Hose Connections: 65 psig

b. NPS 2-1/2 Hose Connections: 100 psig

2. Unless otherwise indicated, the following is maximum, residual pressure at required flow at each hose-connection outlet:

a. NPS 1-1/2 Hose Connections: 100 psig

b. NPS 2-1/2 Hose Connections: 175 psig

3. A flow switch shall be provided for each standpipe.

1.8 COMBINED STANDPIPES AND SPRINKLER SYSTEMS

A. Design systems designated to serve as standpipes and to provide sprinkler coverage per NFPA-13 and NFPA-14 requirements.

B. Design shall meet all requirements defined for both stand-alone sprinkler systems and stand-alone standpipe system. A flow switch shall be provided for each standpipe.

1.9 APPROVALS

A. Submit shop drawings, product data, and hydraulic calculations to the Architect/Engineer and Owner for review first; and then submit shop drawings and hydraulic calculations to, and obtain approval from, government agencies having jurisdiction and the Owner's insurance underwriter prior to construction.

1.10 SUBMITTALS

A. Submit hydraulic calculations with the sprinkler design drawings and fire protection equipment specified for the project for review, prior to construction.

B. Approved hydraulic calculations shall be included in the Operating and Maintenance Manuals.

C. Fire protection system shop drawings shall include all applicable data as required by NFPA-13, Latest Edition, "Working Plans".

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 21 09 10

SECTION 21 10 10
COMMON PIPING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies piping materials and installation methods common to more than one section of Division 21 and includes fittings, joining methods, and basic piping installation instructions.

B. Not all pipe materials and joining methods listed in this section pertain to this project. See specific system sections within this Division's specifications for approved materials and installation methods pertaining to this project.

C. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 QUALITY ASSURANCE

A. Design and installation of Fire Protection systems shall be performed by a state certified contractor.

1.4 CODES AND STANDARDS

A. All fire suppression piping systems shall comply with and be installed in accordance with NFPA.

B. All fire protection piping systems shall be designed and installed in accordance with National Fire Protection Association Standards 13, 14, 24, 25, 90A, 750, and 2001 requirements where they are each applicable.

C. Water Department/Fire Department/Marshal Compliance:

1. Furnish and install fire protection systems in accordance with regulations required by the local Water Department, local Building Department and local Fire Departments.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 21 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 21 04 40.

PART 2 - PRODUCTS

2.1 GENERAL

A. Piping Materials:

1. Refer to individual system specification for allowable locations for each piping material, fitting style, and joining method. The following materials and joining may not be acceptable for certain projects and in certain areas.

2. Provide pipe of type, joint type, grade, size and weight (wall thickness or class) indicated for each service in other Division 21 sections of this specification.

3. Where type, grade or class is not indicated, provide proper selection as determined by installer for installation requirements, and comply with governing regulations and industry standards.

B. Pipe Joints and Fittings:

1. Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size.

2. Provide sizes and types of matching pipe, valve or equipment connections in each case.

3. After cutting, ream ends of piping and remove all burrs. Remove all scale, slag dirt and debris from both inside and outside of piping and fittings before assembly. Swab if necessary for thorough cleaning. No metal shall project within the pipe.

4. Pipe to be threaded shall be cut square and fully threaded with tapering threads. Apply pipe joint compound to male thread end of all threaded joints. Joint compound shall be compatible with the service of the piping. The piping shall be carefully aligned.

5. Where not otherwise indicated, comply with governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable.

6. Strap-o-lets shall not be permitted. Taps into existing mains or branch piping shall be made via factory formed tee fittings.

2.2 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell end and plain end.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile-or gray-iron; AWWA C153, ductile-iron.

2. Glands, Gaskets, and Bolts: AWWA C111, ductile-or gray-iron gland, rubber gasket, and steel bolts and nuts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell end and plain end.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile-or gray-iron; AWWA C153, ductile-iron.

2. Gaskets: AWWA C111, rubber.

2.3 STEEL PIPE AND FITTINGS

A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory-or field-formed threaded ends.

1. Cast-Iron Threaded Flanges: ASME B16.1.

2. Malleable-Iron Threaded Fittings: ASME B16.3.

3. Gray-Iron Threaded Fittings: ASME B16.4.

4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.

5. Steel Threaded Couplings: ASTM A 865.

B. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed, roll grooved ends.

1. Grooved-Joint Piping Systems Acceptable Manufacturers:

a. Anvil International, Inc.

b. Victaulic Co. of America

2. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.

3. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, [prelubricated] rubber gasket listed for use with housing, and steel bolts and nuts.

C. Pipe Joining Materials

1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.

a. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.

b. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

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

3. Grooved Couplings shall be compatible with gasketing materials.

2.4 FLEXIBLE CONNECTORS

A. Flexible connectors shall have materials suitable for system fluid. Include 175-psig minimum working-pressure rating and ends according to the following:

1. NPS 2 and Smaller: Threaded.

2. NPS 2-1/2 and Larger: Grooved for use with grooved-end-pipe couplings.

B. Acceptable Manufacturers:

1. Anamet Inc.

2. Flex-Hose Co., Inc.

3. Flexicraft Industries.

4. Flex-Presson, Ltd.

5. Flex-Weld, Inc.

6. Hyspan Precision Products, Inc.

7. Mercer Rubber Co.

8. Metraflex, Inc.

9. Proco Products, Inc.

10. Unaflex Inc.

C. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges welded to hose.

2.5 SPRINKLER SPECIALTY FITTINGS

A. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

B. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping. Sprinkler specialty fittings shall have 250-psig minimum working-pressure rating if fittings are components of high-pressure piping system.

C. Outlet Specialty Fittings:

1. Acceptable Manufacturers:
    a. Anvil International, Inc.
    b. Central Sprinkler Corp.
    c. Ductilic, Inc.
    d. JDH Pacific, Inc.
    e. National Fittings, Inc.
    f. Southwestern Pipe, Inc.
    g. Victaulic Co. of America.
    h. Ward Manufacturing.
2. Mechanical-T and Cross Fittings: UL 213, ductile-iron housing with gaskets, bolts and nuts, and threaded, locking-lug, or grooved outlets.
3. Snap-On and Strapless Outlet Fittings: UL 213, ductile-iron housing or casting with gasket and threaded outlet.

D. Sprinkler Drain and Alarm Test Fittings: Cast-or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.

1. Acceptable Manufactures:
    a. Central Sprinkler Corp.
    b. Fire-End and Crocker Corp.
    c. Tyco
    d. Viking Corp.
    e. Victaulic Co. of America.

E. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.

1. Acceptable Manufacturers:
    a. Elkhart Brass Mfg. Co., Inc.
    b. Fire-End and Croker Corp.
    c. Potter-Roemer, Fire-Protection Div.

F. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.

1. Acceptable Manufacturers:
    a. AGF Manufacturing Co.
    b. Central Sprinkler Corp.
    c. G/J Innovations, Inc.
    d. Triple R Specialty of Ajax, Inc.

G. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.

1. Acceptable Manufacturers:

a. CECA, LLC.

b. Merit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Drawings indicate the general location and arrangement of the piping systems. So far as practical, install piping as indicated making connections to all equipment. Install piping as direct as possible avoiding unnecessary offsets. However, if offsets are required in order to obtain maximum headroom or to avoid conflict with other work, they shall be made as required or as requested by the Architect without additional cost to the Owner. The Architect reserves the right to make minor changes in the location of piping and equipment during the roughing-in, without additional cost to the Owner. All changes proposed by others shall be approved by the Engineer.

B. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

C. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.

E. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.

F. Install "Inspector's Test Connections in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install alarm devices in piping systems.

I. Install piping free of sags or bends.

J. Where piping is installed above accessible ceilings, allow sufficient space between ceiling and pipe to remove ceiling panels.

K. Locate piping installed parallel to each other with adequate space for serving of valves where applicable.

L. Support piping independently so as not to place a strain on valves and equipment.

M. Any piping resting on or coming in contact with building structure shall be insulated at that point to prevent transmission of vibration.

N. All piping shall be installed parallel with, or at right angles to, the building walls. All vertical risers shall be installed plumb and straight. Diagonal runs are not permitted unless expressly indicated on the drawings.

3.2 DELIVERY, STORAGE AND HANDLING

A. Provide factory-applied plastic end-caps on each length of pipe and tube. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris and moisture.

B. Protect Stored Pipes: Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor or structure.

C. Protect flanges, fittings and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

3.3 SERVICE-ENTRANCE PIPING

A. Connect fire-suppression piping to water-service piping of size and in location indicated for service entrance to building. Refer to Division 21 Section "Facility Water Distribution Piping" for exterior piping.

B. Install shutoff valve, double detector check backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Refer to other Division 21 Sections for double detector check backflow preventers.

3.4 WATER-SUPPLY CONNECTION

A. Connect fire-suppression piping to building's interior water distribution piping. Refer to other Division 21 Sections for interior piping.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water distribution piping. Refer to other Division 22 Sections for backflow preventers.

3.5 FIELD QUALITY CONTROL

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

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.

3. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.

END OF SECTION 21 10 10

SECTION 21 10 20
WET-PIPE SYSTEM PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies piping materials and installation methods for wet-pipe fire protection system piping.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all piping work described in this Section.

C. See drawings and each specific system description indicated herein for specific sizes, materials and installation methods pertaining to this project. Portions of this Section may not be required for this project.

1.3 QUALITY ASSURANCE

A. Installation of the sprinkler system shall be performed by a state certified contractor.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 21 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 21 04 40.

PART 2 - PRODUCTS

2.1 PIPING AND FITTING TABLE

A. The table below identifies the acceptable pipe materials, fitting types, and joint methods allowed for each pipe service and size. Where multiple options are listed, the option used shall be at the discretion of the Contractor.

Table 21 10 20.1

Service	Size	Pipe Material	Fittings	Type of Joint
Sprinkler Pipe	2” and smaller	Schedule 40 Black Steel Pipe, ASTM A 53/A 53 M, Type E, Grade B	Factory formed gray iron threaded fittings, per ASTM B16.4, Class 125 standard pattern	T
	1-1/2” – 2"	Schedule 40 Black Steel, ASTM A 53/A 53 M, Type E, Grade B	Factory formed ductile iron, per ASTM A-536 with grooved ends	G

	2-1/2" and larger	Schedule 10 Black Steel, ASTM A 53/A 53 M, Type E, Grade B	Factory formed ductile iron, per ASTM A-536 with grooved ends	G
Fire	All sizes	Schedule 10 Black Steel, ASTM A 53/A 53 M, Type E, Grade B	Factory formed ductile iron, per ASTM A-536 with grooved ends	G
Standpipe	All sizes	Schedule 10 Black Steel, ASTM A 53/A 53 M, Type E, Grade B	Factory formed ductile iron, per ASTM A-536 with grooved ends	G
*Joint Methods : G=Grooved, T=Threaded				

PART 3 - EXECUTION

3.1 SYSTEM DESIGN

A. A. System design shall be in accordance with standard industry practice for fire sprinkler systems and the manufacturer's instructions. The design shall take into consideration such factors as pressure and flow requirements, friction loss, operating temperatures, support spacing, joining methods, and thermal expansion and contraction.

B. The fire sprinkler piping system shall be hydraulically calculated using a Hazen-Williams C Factor of 150, and designed in accordance with the Standard for Installation of Sprinkler Systems, NFPA 13.

C. The maximum design temperature/pressure rating shall not exceed 175 psi at 150°F.

3.2 PIPING INSTALLATION

A. Refer to Division 21 Section 21 10 10 "Common Piping Requirements" for general piping installation requirements.

B. Installation practices such as pipe support spacing, bracing, allowance for thermal expansion/contraction, solvent cementing and handling and storage shall be in accordance with the manufacturer's instructions and the UL Listing which includes installation limitations.

C. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.

D. Install all sprinkler piping systems with drains for complete system drainage. Trapped piping sections should be avoided where possible. Where existing conditions or obstructions necessitate installation of a trapped section, furnish valved drain with hose thread connection.

E. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

F. Install alarm devices in piping systems.

G. Hangers and Supports: Comply with NFPA 13 for hanger materials.

1. Install sprinkler system piping according to NFPA 13.

H. Install pressure gages on riser or feed main and at each sprinkler test connection. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

I. Fill wet-pipe sprinkler system piping with water.

3.3 TESTING

A. Sprinkler piping systems specified herein shall be tested per Section 21 03 10 "System and Component Flushing and Testing".

B. After the system is installed and any solvent cement is cured per the manufacturer's installation instructions, the systems shall be hydrostatically tested per the requirements of the applicable NFPA Standards.

3.4 MAINTENANCE

A. Maintenance shall be in accordance with the Standard for Inspection, Testing and Maintenance of Water Based Extinguishing Systems as defined by NFPA 25.

END OF SECTION 21 10 20

SECTION 21 10 30
WATER SERVICE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications complement the requirements of this Section.

C. Refer to 21 10 10 for Common Piping Requirements.

1.2 SCOPE

A. This Section specifies piping materials and installation methods for wet fire protection system service piping, and includes fittings, joining methods, and special piping installation instructions.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all piping work described in this Section.

C. See drawings and each specific system description indicated herein for specific sizes, materials and installation methods pertaining to this project. Portions of this Section may not be required for this project.

D. This Contractor shall be certified by the State and registered with the local municipality for installation of underground fire service piping. This Contractor shall secure all permits as required.

1.3 CODES AND STANDARDS

A. Water Department/Fire Department/Marshal Compliance:

1. Furnish and install fire protection water service piping systems in accordance with regulations required by the local Water Department, local Building Department and local Fire Departments.

B. All fire protection piping systems shall be installed in accordance with National Fire Protection Association Standards 13 and 24 requirements as applicable.

C. All on-site water line piping and appurtenances shall be installed according to the local Water Department specifications and must be inspected and approved by the City Water Distribution Division prior to back-filling.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 21 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 21 04 40.

PART 2 - PRODUCTS

2.1 PIPING AND FITTING TABLE

A. The table below identifies the acceptable pipe materials, fitting types, and joint methods allowed for each pipe service and size.

B. Pipe schedules refer to ANSI B36.

C. Pipe sizes refer to Nominal Pipe Sizing (NPS) standards.

Table 21 10 30.1

Service	Size	Pipe Material	Fittings	Type of Joint
Water Service (outside the building and upstream of double detector check valve assembly)	All sizes	AWWA C151 Class 53 ductile iron, with ANSI/AWWA C104/A21.4 cement lining. Provide labeled polyethylene encasement per AWWA C105.	Class 350 ductile iron compact fittings per AWWA C153 or full thickness castings per AWWA C110, with mechanical joint ends and ductile iron follower glands	PO
*Joint Methods: PO=Push-On				

2.2 PIPE JOINT MATERIALS

A. Push-on joints (Tyton, Bell-Tite, etc.), per AWWA C151 specifications with plain or restraining rubber gaskets per AWWA C111 specifications.

2.3 RESTRAINED PIPE SYSTEMS:

A. Push-on joint with Field Lock (4 through 12 inch only) or Fast Grip gaskets (4 through 12 inch only), or mechanical joint with restrained follower glands, and 6 ounce zinc anode caps on every other bolt thread. Super Lock, TR Flex or Flex-Ring required on all 16 inch or larger pipe diameters.

2.4 RESTRAINED FITTING DEVICES

A. All valves, bends, offsets, hydrant inlets, caps, plugs, and branches of tees and wyes must be restrained using mechanical joint with restrained follower glands or restraining gaskets. Hardwood blocking is required for all diameters 12 inch and larger. Concrete blocking is required on all fire lines and on all diameters in areas over 100 psi. Restrained joints for diameters 12 inch and under shall be installed for a length of 30 feet on each side of a valve, bend or offset using Field-Lock or Fast-Grip restraining gaskets or mechanical joint with restrained follower glands. Restrained joints for diameters 16 inch and larger, shall be installed for a length of 30 feet on each side of a valve, bend or offset using mechanical joint with restrained follower glands.

2.5 MECHANICAL JOINT T-HEAD BOLTS

A. All mechanical joints shall be made with Cor-Ten or construction-grade alloyed ductile iron bolts. T-head bolts shall be ½ inch longer than standard length and must include a 6 oz. zinc anode cap on every other bolt thread.

2.6 GATE VALVES

A. Provide resilient-seat wedge (RSW) valves with restrained mechanical joints. Valves shall have non-rising stems and shall open to the right (clockwise).

2.7 VALVE BOXES

A. Provide only Bibby or Bingham and Taylor brands acceptable for compatibility.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Refer to Division 21 Section "Common Piping Requirements" for basic piping installation.

B. All underground pipe shall be installed with 4 feet 6 inches of cover. See detailed water department specifications for approved pipe, fittings, bolts, etc., for water line installation.

C. Maintain a 12 inch minimum vertical clearance from edge of water line to edge of storm sewers and/or inlet lead where they cross.

D. Maintain a 4 foot minimum horizontal clearance from edge of water line to edge of storm sewer.

E. Maintain a 10 foot horizontal clearance from edge of water line to edge of sanitary sewer.

F. Maintain an 18 inch minimum vertical clearance from edge of water line to edge of sanitary sewer where they cross.

G. Maintain a 12 inch vertical clearance from edge of water line to edge of gas, electric, etc.

H. Maintain a 5 foot minimum horizontal clearance from edge of water line to edge of gas lines(s), electric line(s), communication line(s), etc.

I. In buildings with interior meter setting without basements, water service line must be installed in an AWW approved conduit from one foot outside footer to above floor slab.

J. Buildings with interior meter settings not on an outside wall, the water service line must be installed in a continuous AWW approved conduit from outside building footer up through floor slab.

K. Water service line installed under paved areas for inside meter setting must be in an AWW approved conduit from street right-of –way to inside building.

3.2 TESTING

A. Piping systems specified herein shall be tested per the “Piping Systems Integrity Verification” section of Division 21 Specifications.

3.3 CLEANING AND PURGING

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

1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.

2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.

3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:

a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.

b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.

c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.

d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

4. Prepare reports of purging and disinfecting activities.

END OF SECTION 21 10 30

SECTION 21 12 10
PIPING IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies fire protection system equipment and piping identification and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. All pipe markers shall conform to ANSI A13.1 "Scheme for the Identification of Piping Systems".

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 21 01 10.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products as manufactured by one of the following:

1. Brady Corporation
2. Brimar Industries, Inc.
3. Craftmark Identification Systems
4. DuraLabel/Graphic Products
5. Identification Depot
6. Kolbi Pipe Marker Co.
7. Seton Identification Products

2.2 GENERAL

A. A Coordinated system of piping and equipment identification shall be provided which includes the following:

1. Framed and plastic protective diagrammatic layout of all piping systems, identifying and locating piping, equipment, and valves.
2. Metal tags identifying major valves, piping system components and equipment.
3. Service labeled piping.
4. Metal identification plate at controlling alarm valve identifying system and area protected.

B. DIAGRAMS

1. This Contractor shall provide a chart listing of valves and equipment by designation number and shall show pertinent data. Diagrams shall be neat, mechanical drawings mounted in extruded aluminum frames, with 1/8 inch thick acrylic plastic protection.

2. Mounting location of diagrams shall be as directed by the Owner's Representative. Typical location shall be in the sprinkler riser room.

3. A minimum of one mounted chart and diagram, plus one extra copy of each, shall be provided for each fire protection system in the O+M manual.

2.3 PIPE IDENTIFICATION LABELS

A. Colored, precoiled plastic, designed to install without the need for tape or a band. Markers to include flow direction arrows and lettering describing pipe's contents. Markers shall provide 360° visibility.

B. Markers for installation on piping with outside diameter less than 6" (including insulation) shall be snap-around type. Markers for installation on piping with outside diameter 6" or greater (including insulation) shall be strap-around type.

C. Marker colors shall be based on hazard levels of material contained in piping.

D. Piping, including that concealed in accessible spaces, shall be labeled to designate service. Each label shall include an arrow or arrows to indicate flow direction. Labels or tag designation shall be as follows:

Service	Label or Tag Designation
Main sprinkler supply	MAIN SPRINKLER SUPPLY
Sprinkler riser number	SPRINKLER RISER NO.
Sprinkler Branch	SPRINKLER BRANCH
Standpipe	STANDPIPE
Drain Piping	Drain
Inspectors Test Piping	Inspector's Test

E.

F. Piping shall be labeled and arrowed in accordance with the following:

1. Each point of entry and exit through walls.

2. Each change of direction.

3. In congested or hidden areas, at each point required to clarify service or indicate hazard.

4. In long straight runs, labels shall be located at a distance visible to each other, but in no case shall the distance between labels exceed 40 feet.

G. Label lettering shall be approximately 1-1/2 to 2 inches high based on outside pipe diameter. Labels shall be legible from the primary service and operating level.

H. Labels shall be made of self sticking plastic film designed for permanent installation. Labels shall have red letters on white background.

I. Label and valve tag schedule above shall not be construed as defining or limiting the work. All piping systems shall be labeled.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Pipe Markers

1. Install pipe markers at the following locations:
    a. Adjacent to valves.
    b. Where pipes pass through walls, on both sides of wall.
    c. Where pipes pass through floor, above floor, within two feet of floor level.
    d. Near all branches and changes in direction.
    e. At 20 foot intervals on straight runs of pipe.
    f. At access door locations.

B. Valve Tags
1. All fire system drain valves and control valves shall be tagged.
2. At the completion of the project, provide a valve directory for each system. Include a copy of each directory in the Operating and Maintenance Manual. Coordinate the valve designation/numbering system with the Owner. Directory shall include valve designation/number, service, building location, size and equipment/fixtures controlled.

3.2 ADJUSTING AND CLEANING

A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.

B. Cleaning: Clean face of identification devices and glass frames of valve charts.

END OF SECTION 21 12 10

SECTION 21 12 20
PIPING HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies piping hanging and supporting methods common to more than one section of Division 21 and includes hangers, supports, saddles, shields, clamps, inserts, and miscellaneous materials necessary for the proper hanging and supporting of piping systems. Portions of this Section may not be required in this project. See drawings and each specific system description section of Division 21 for specific sizes; materials and installation methods pertaining to this project.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. All fire protection system piping shall be supported in accordance with National Fire Protection Association requirements. Hangers and supports shall be UL Listed and FM Approved. Where UL Listed or FM approved hangers are not utilized due to location, orientation or other field condition, the hangers and methods employed shall be as required by NFPA requirements.

B. Hangers and supports shall comply with ANSI/Manufacturer's Standardization Society (MSS) SP-58, SP-69 and SP-89.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 21 01 10.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with these specifications, pipe hanger and support systems shall be as manufactured by one of the following:

1. ANVIL
2. ELCEN
3. ERICO, Inc.
4. Fee and Mason
5. Grinnel
6. Hydra-Zorb Company
7. MetraFlex
8. PHD Manufacturing Inc.
9. Pipe Shields

2.2 HORIZONTAL PIPE HANGERS AND SUPPORTS

A. In general, hang all individual horizontal piping supported from above with the following pipe hangers. Model numbers are based on “Erico”.

1. Uninsulated steel iron piping 2" and smaller – Model 100 heavy duty galvanized steel swivel loop hanger.

2. Uninsulated steel or cast iron piping 2-1/2" and larger – Model 400 carbon steel clevis hanger.

B. Support all pipe hangers from all-thread rod with additional lock nut. All-thread rod size shall match hanger attachment size. Attach all hangers to the structure with concrete inserts, "C" clamps, beam clamps, or ceiling flanges.

1. Hangers and supports anchored to poured concrete: Use malleable iron or steel concrete inserts attached to concrete forms.

2. Hangers or supports anchored to precast concrete: Use self-drilling expansion shields. Expansion shields may also be used where concrete inserts have been missed or additional support is required in poured concrete.

3. Attach all-thread rod 5/8" or smaller to steel with malleable iron beam clamps with carbon steel retainer strap.

4. Attach all-thread rod 3/4" or larger to steel with carbon steel center-load beam clamps with forged steel eye nut.

5. Attach all-thread rod to ceiling with malleable iron ceiling flanges, anchored to structural member above ceiling.

6. All adhesive hangers shall be approved for use with cracked concrete per the American Concrete Institute and ICC-ES standard AC308. All mechanical hangers shall be approved for use with cracked concrete per the American Concrete Institute and ICC-ES standard AC193.

2.3 VERTICAL PIPE FRICTION CLAMPS

A. In general support all vertical piping with friction type riser clamps.

1. Steel or cast iron piping – carbon steel.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide all hangers, supports and clamps to properly support and retain piping, to control expansion, contraction and drainage and to prevent sway and vibration.

B. Examine areas and conditions where the hangers, supports, clamps and inserts are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the installer. Proceed only after the required building structural work has been completed in the area where the piping is to be installed.

C. The use of explosive force hammer actuated, booster assist or similar anchoring device is not permitted without prior approval from Architect.

D. Provide all supplementary angles, channels, rails and plates required for support of piping. Attach to building structural members by welding, bolting or anchoring. Ceiling flanges shall be secured to the structural member above ceiling - anchoring ceiling flanges to drywall "only" is not acceptable.

E. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze hangers. Construct of a channel or unistrut with adjustable all-thread rods. Hanger spacing shall be determined by the smallest pipe supported.

F. Install hangers and supports to allow for controlled movement of the piping system, to permit movement between pipe anchors and to facilitate the action of expansion joints and bends.

G. Install hangers and supports to provide pipe slopes required for drainage.

H. Support all fire protection piping independently of other piping, per NFPA requirements.

I. Do not support piping from another pipe or from ductwork or equipment. Do not support ceiling framing or lighting from piping.

J. Adjust hangers and supports to equally distribute the load between all supporting members.

K. Support all piping independently from equipment. No piping is to impose a load upon the equipment to which it is connected.

END OF SECTION 21 12 20

SECTION 21 12 30
PRESSURE GAUGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications complement the requirements of this Section.

1.2 SCOPE

A. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 SUMMARY

A. This Section specifies gauges common to more than one section of Division 21 and includes materials, specialties, and basic installation instructions. Portions of this Section may not be required in this project. See drawings and each specific system description section of Division 21 for specific sizes; materials and installation methods pertaining to this project.

1.4 CODES AND STANDARDS

A. UL Compliance: Comply with applicable UL standards pertaining to thermometers and gauges.

B. ASME and ISA Compliance: Comply with applicable portions of ASME and Instrument Society of America (ISA) standards pertaining to construction and installation of thermometers and gauges.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 21 01 10.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide pressure gauges as manufactured by one of the following:

1. AMETEK; U.S. Gauge Division.
2. Ashcroft, Inc.
3. Brecco Corporation.
4. Weiss Instruments, Inc.
5. WIKA Instrument Corporation.

2.2 GENERAL

A. Standard: UL 393, FM

B. General use, ANSI B40.1 grade A

2.3 CASING

A. Dial Size: 3-1/2- to 4-1/2-inch diameter.

B. Aluminum dial with white background and permanently etched black markings.

C. Aluminum pointer with black finish.

D. Window: Clear polycarbonate

2.4 RANGE

A. Pressure Gage Range: 0 to 250 psig minimum.

2.5 IDENTIFICATION

A. Water System Piping Gage: Include "WATER" label on dial face.

B. Air System Piping Gage: Include "AIR" label on dial face.

2.6 ACCURACY

A. Plus or minus 3%.

2.7 STEM

A. Phosphor bronze bourdon-tube and brass socket for 1/4" NPT bottom connection.

B. Provide gauges with 1/4" NPT brass bushing snubbers with corrosion resistant porous metal disc suitable for the service and pressure rating of the piping system where installed. Between gauge and tee in piping system, provide 1/4" bronze body, threaded ball valve suitable for the service and pressure rating of the piping system where installed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pressure gauges located in the piping at the most readable location for an observer standing on the floor.

B. Install with shut off valve and snubber.

C. Install as close as possible to the equipment or apparatus to indicate pressure changes across equipment or apparatus only. Adjust faces to proper angle for best visibility.

D. Install pressure gauges in the following locations and elsewhere as indicated.

1. At suction and discharge of each fire and jockey pump.

2. At inlet and outlet of each pressure reducing valve.

3. At the top of each standpipe.

3.2 ADJUSTING AND CLEANING

A. Adjusting: Adjust faces of gauges to proper angle for best visibility.

B. Cleaning: Clean windows of pressure gauges and factory-finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touch-up paint.

C. Connections: Piping installation requirements are specified in other sections of Division 21. The drawings indicate the general arrangement of piping, fittings and specialties. The following are specific connection requirements:

1. Install pressure gauges piping adjacent to equipment to allow servicing and maintaining of equipment.

END OF SECTION 21 12 30

SECTION 21 12 40
FIRE PUMP TEST HEADERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies fire protection system piping specialties, and accessories, and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of fire protection specialties of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Fire Protection specialty Types: Provide fire protection specialties of same type by same manufacturer.

1.4 CODES AND STANDARDS

A. Regulatory Requirements: Comply with requirements of the following codes:

1. NFPA and OBC compliance:

a. Install fire protection devices within fire protection systems in accordance with NFPA 13 "Standard for the Installation of Sprinkler Systems", NFPA 20 "Installation of Stationary Pumps for Fire Protection' and all OBC requirements.

2. UL Compliance:

a. Fire protection system materials and components shall be Underwriter's Laboratories listed and approved for the application anticipated.

3. Water Department/Fire Department/Marshall Compliance:

a. Furnish and install fire protection systems on accordance with regulations required by local Water Department, Fire Department, and Fire Marshal.

b. Comply with standards of authorities having jurisdiction pertaining to materials, hose threads, and installation.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 21 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 21 04 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide fire pump test headers as manufactured by one of the following:

1. Cla-Val
2. Potter Roemer
3. Patterson
4. Viking

2.2 GENERAL

A. Furnish fire department hose connections compatible with the Local Fire Department requirements.

B. According to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "AUTO SPKR & STANDPIPE."

C. Valve shall be designed to allow 250 gpm per test connection.

2.3 CONSTRUCTION

A. Provide fire pump test connections with either polished cast brass angle inlet body or with ductile iron (ASTM A536-65) body with fusion bonded red epoxy coating.

B. Body shall be formed from a single casting. No welding permitted.

C. Inlet shall be flanged 150# Class or Grooved end, as identified on the drawings.

2.4 HOSE VALVES

A. Brass hose gate valves shall be supplied with every other valve having a loose bonnet as required for installation, female NPT inlet x 2-1/2" male hose thread outlet, 2-1/2" caps and chains.

B. 18" long polished brass cover sleeve and brass identification plate lettered "FIRE PUMP TEST CONNECTION".

C. Arrangement of outlets shall comply with local Fire Department requirements.

PART 3 - EXECUTION

3.1 GENERAL

A. Furnish all labor, construction equipment and materials necessary for the complete installation of the fire protection system specialties.

B. Work shall be in strict compliance with all governing state and local code requirements, in full conformity with the best current trade practices and subject to approval of the Architect or his Representative.

3.2 EXAMINATION

A. Examine areas and conditions under which fire pump test headers are to be installed.

B. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.3 INSTALLATION

A. All work details not covered in these Specifications shall be governed by the requirements of the latest edition of NFPA.

B. Locate all fire pump test headers not more than five feet above finished grade. Coordinate elevation with local fire department.

C. Install a ball drip valve at the base of the fire pump test header pipe riser. Ball drip valve shall be installed such that it drains all excess water from the fire pump test header such that no standing water is left in the test header or exterior exposed piping that may be subject to freezing. Pipe ball drip valve to drain to the nearest floor drain or to drain outside of the building.

D. Install fire pump test header in a vertical, exterior wall.

E. Seal all penetrations of exterior wall with appropriate caulking to maintain weatherproof integrity of the exterior wall.

3.4 CONNECTIONS

A. Drawings indicate general arrangement of piping.

B. Coordinate mounting location of fire pump test header and align piping with header connection.

C. Acceptable pipe joint types shall be per other sections of these Division 21 specifications. Coordinate joint style with test header manufacturer prior to order.

3.5 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 20.

3.6 FIELD QUALITY CONTROL

A. Verify that equipment hose threads are same as local fire department equipment.

END OF SECTION 21 12 40

SECTION 21 13 10
FIRE PROTECTION VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies fire protection valves common to more than one section of Division 21 and includes materials, specialties, and basic installation instructions. Portions of this Section may not be required in this project. See drawings for specific valve types.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. Valve face-to-face and end-to-end dimensions shall comply with ANSI requirements.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 21 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 21 04 40.

1.5 DELIVERY, STORAGE, HANDLING

A. Store all valves and materials on site or off site to avoid damage due to construction and activity and weather.

PART 2 - PRODUCTS

2.1 GENERAL

A. Where possible provide all valves of the same manufacturer. All valves shall have the manufacturer's name (or trademark) and pressure rating clearly marked on the valve body.

B. Provide factory-fabricated valves of types and temperature/pressure ratings as indicated, suitable for the service in which the valve is installed.

C. Unless otherwise indicated, provide valves of same size as largest adjacent pipe size.

D. Inspector test valves and drain valves for use in sprinkler systems shall be bronze body, two piece, ball valves with solder or threaded ends to match piping.

E. All valves shall be UL listed and FM approved, suitable for installation in fire protection systems per NFPA requirements, 175-psig WOG.

2.2 GATE VALVES WITH WALL INDICATOR POSTS

A. Gate Valves: UL 262, FM approved, cast-iron alloy body according to ASTM A-126 class B with OS&Y type bonnet, epoxy coated interior, bronze mounted, with solid disc, non-rising stem, operating nut, and class 125 flanged ends, 175 psi WWP or greater, resilient rubber encapsulated wedge

B. Indicator Posts: UL 789, horizontal-wall type, cast-iron body, with hand wheel, extension rod, locking device, and cast-iron barrel.

C. Acceptable Manufacturers:

1. Crane
2. McWane, Inc., Kennedy Valve Division
3. Milwaukee
4. NIBCO
5. Stockham

2.3 BALL VALVES

A. Comply with UL 1091, except with ball instead of disc.

B. Acceptable Manufacturers:

1. Anvil International
2. Milwuakee
3. NIBCO
4. Victaulic Co. of America

C. 1-1/2" and Smaller: Bronze body with threaded ends.

D. 2" and 2-1/2": Bronze body with threaded ends or ductile-iron body with grooved ends.

E. 3": Ductile-iron body with grooved ends.

2.4 BUTTERFLY VALVES

A. UL 1091, 175 psig pressure rating with integral valve supervisory switch.

B. 2" and Smaller: Bronze body with threaded ends.

1. Acceptable Manufacturers:
   a. Anvil International
   b. Global Safety Products, Inc
   c. Milwaukee Valve Company
   d. NIBCO
   e. Tyco
   f. Victaulic

C. 2-1/2" and Larger: Bronze, cast-iron, or ductile-iron body; with flanged or grooved ends.

1. Acceptable Manufacturers:
   a. Central Sprinkler Corp
   b. Global Safety Products, Inc
   c. McWane, Inc., Kennedy Valve Division
   d. Mueller Company
   e. NIBCO
   f. Pratt, Henry Company
   g. Tyco

h. Victaulic Co. of America

2.5 CHECK VALVES

A. 2" and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and threaded ends.

B. 2" and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.

C. Acceptable Manufacturers:

1. Anvil International
2. Central Sprinkler Corp
3. Crane Co
4. Grinnell Fire Protection
5. Hammond Valve.
6. McWane, Inc.; Kennedy Valve Div.
7. Milwaukee
8. Mueller Company
9. NIBCO.
10. Potter-Roemer; Fire Protection Div.
11. Reliable Automatic Sprinkler Co., Inc.
12. Star Sprinkler Inc.
13. Victaulic Co. of America
14. Watts Industries, Inc.; Water Products Div.

2.6 GATE VALVES

A. UL 262, OS&Y type.

B. 2" and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, solid wedge, and threaded ends.

1. Acceptable Manufacturers:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Hammond Valve.
c. NIBCO
d. United Brass Works, Inc.

C. 2-1/2" and Larger: Cast-iron body with flanged ends.

1. Acceptable Manufacturers:

a. Clow Valve Co.
b. Crane Co.; Crane Valve Group; Crane Valves
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Hammond Valve.
e. Milwaukee Valve Company.
f. Mueller Company.

g. NIBCO.

h. Red-White Valve Corp.

i. United Brass Works, Inc.

D. Design: Signals that controlled valve is in other than fully open position.

2.7 FIRE DEPARTMENT VALVES

A. 2-1/2" cast brass, angle type, red handwheel, UL listed and FM approved, female NPT inlet.

B. Valve outlet shall be 2-1/2". Outlet threads shall match the Local Fire Department requirements.

C. Provide with cap and chain.

D. Acceptable manufacturers

1. AFAC Inc.

2. Central Sprinkler Corp.

3. Elkhart Brass Mfg. Co., Inc.

4. Fire-End and Croker Corp.

5. Fire Protection Products, Inc.

6. GMR International Equipment Corporation.

7. Grinnell Fire Protection.

8. Guardian Fire Equipment Incorporated.

9. McWane, Inc.; Kennedy Valve Div.

10. Mueller Company.

11. Potter-Roemer; Fire-Protection Div.

12. United Brass Works, Inc.

E. Description: UL 668, brass or bronze, 300-psig minimum pressure rating, hose valve for connecting fire hose. Include angle or gate pattern design; female NPS inlet and male hose outlet; and lugged cap, gasket, and chain. Include NPS 1-1/2 or NPS 2-1/2 as indicated, and hose valve threads according to NFPA 1963 and matching local fire department threads.

1. Valve Operation: Nonadjustable type, unless pressure-regulating type is required.

2. Finish: chrome-plated.

2.8 TRIM AND DRAIN VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.

2. Pressure Rating: 175 psig minimum.

2.9 SPECIALTY VALVES

A. Sprinkler System Control Valves: UL listed or FMG approved, cast- or ductile-iron body with flanged or grooved ends, and 175-psig minimum pressure rating. Control valves shall have 250-psig minimum pressure rating if valves are components of high-pressure piping system.

1. Body Material: Cast or ductile iron.

2. Size: Same as connected piping.

3. End Connections: Flanged or grooved.

B. Acceptable manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFAC Inc.
2. Central Sprinkler Corp.
3. Firematic Sprinkler Devices, Inc.
4. Globe Fire Sprinkler Corporation.
5. Grinnell Fire Protection.
6. Reliable Automatic Sprinkler Co., Inc.
7. Star Sprinkler Inc.
8. Venus Fire Protection, Ltd.
9. Victaulic Co. of America.
10. Viking Corp.

2.10 ALARM VALVES

A. Acceptable manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFAC Inc.
2. Reliable Automatic Sprinkler Co., Inc.
3. Tyco Fire & Building Products LP.
4. Viking Corporation.
5. Victaulic.

B. Standard: UL 1930

C. Design: For horizontal or vertical installation.

D. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, drip cup assembly piped without valves and separate from main drain line, fill line attachment with strainer.

E. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

2.11 AUTOMATIC (BALL DRIP) DRAIN VALVES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFAC Inc.
2. Reliable Automatic Sprinkler Co., Inc.
3. Tyco Fire & Building Products LP.

B. Standard UL 1726.

C. Pressure Rating: 175 psig minimum.

D. Type: Automatic draining, ball check.

E. Size: NPS ¾.

F. End Connections: Threaded.

2.12 PRESSURE REGULATING VALVES

A. UL 1468, brass or bronze, NPS 2-1/2, 400-psig minimum rating. Include female NPS inlet and outlet, adjustable setting feature, and straight or 90-degree-angle pattern design as indicated.

B. Finish: Rough metal.

C. Acceptable Manufacturers:

1. AFAC Inc.
2. Elkhart Brass Mfg. Co., Inc.
3. Fire-End and Croker Corp.
4. GMR International Equipment Corporation.
5. Grinnell Fire Protection.
6. Potter-Roemer; Fire Protection Div.
7. Zurn Industries, Inc.; Wilkins Div.

PART 3 - EXECUTION

3.1 GENERAL

A. All valves shall be installed in accessible locations in a position to allow full stem movement. On horizontal overhead runs, install valves with stems in the horizontal position. On horizontal runs near the floor, install valves with stems in the vertical or 45° angle position.

B. In no case shall valves be installed with stems below the horizontal position.

C. Provide 3/4" drain valves with hose thread fitting and cap with chain at all piping low points, trapped sections, bases of risers, and on equipment side of shut-off valves to permit draining.

3.2 INSTALLATION

A. Install listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA 13 and 24 where applicable and as required by the Local Building Code.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection.

D. Install shutoff valves at the base of each standpipe per NFPA 24 requirements.

E. Install listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA 13 and NFPA 14 and authorities having jurisdiction.

F. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.

G. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.

3.3 FIELD QUALITY CONTROL

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

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Energize circuits to electrical equipment and devices.
4. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.4 APPLICATIONS

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

1. Listed Fire-Protection Valves: UL listed and FMG approved for applications where required by NFPA 13 and NFPA 14.
   a. Shutoff Duty: Use ball, butterfly, or gate valves.
2. Unlisted General-Duty Valves: For applications where UL-listed and FMG-approved valves are not required by NFPA 13 and NFPA 14
   a. Shutoff Duty: Use ball, butterfly, or gate valves.
   b. Throttling Duty: Use ball or globe valves.

END OF SECTION 21 13 10

SECTION 21 13 40
SUCTION CONTROL VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies fire pump suction control valves and includes materials, requirements, and basic installation instructions.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. Valve connection flanges shall comply with ANSI requirements.

B. Valve body shall comply with ASTM requirements.

C. Valve internal components shall comply with AISI requirements.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 21 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 21 04 40.

1.5 DELIVERY, STORAGE, HANDLING

A. Store all valves and materials on site or off site to avoid damage due to construction and activity and weather.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide fire pump suction control valve as manufactured by one of the following manufacturers specified:

1. Cla-Val
2. Watts Regulator Co.
3. Febco

2.2 GENERAL

A. Where possible provide all valves of the same manufacturer. All valves shall have the manufacturer's name (or trademark) and pressure rating clearly marked on the valve body.

B. Provide factory-fabricated valves of types and temperature/pressure ratings as indicated, suitable for the service in which the valve is installed.

C. Unless otherwise indicated, provide valves of same size as largest adjacent pipe size.

D. Inspector test valves and drain valves for use in sprinkler systems shall be bronze body, two piece, ball valves with solder or threaded ends to match piping.

2.3 VALVE BODY

A. All valves shall be FM approved, suitable for installation in fire protection systems per NFPA requirements, 175-psig WOG.

1. Gate Valves: UL 262, cast-iron body, bronze mounted, with solid disc, non-rising stem, operating nut, and flanged ends.

2. 2-1/2" and Larger: Bronze, cast-iron, or ductile-iron body; with flanged or grooved ends.

3. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.

4. Pressure Rating:

a. Standard Pressure Piping Specialty Valves: 175 psig minimum.

5. Body Material: Cast or ductile iron.

6. Size: Same as connected piping.

7. End Connections: Flanged or grooved.

PART 3 - EXECUTION

3.1 GENERAL

A. All suction control valves shall be installed in accessible locations.

3.2 VALVE INSTALLATION

A. Install listed fire pump suction control valves and trim according to NFPA 13, 14, 20 and 24 where applicable and as required by the Local Building Code.

END OF SECTION 21 13 40

SECTION 21 20 10
EQUIPMENT IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies fire protection system equipment identification and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. All equipment markers shall conform to ANSI A13.1 STDS.

B. All fire protection equipment and fire department connection identification shall comply with NFPA 13.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 21 01 10.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products as manufactured by one of the following:

1. Brady Corporation
2. Brimar Industries, Inc.
3. Craftmark Identification Systems
4. DUraLabel/Graphic Products
5. Kolbi Pipe Marker Co.
6. Seton Identification Products

2.2 GENERAL

A. A Coordinated system of piping and equipment identification shall be provided which includes the following:

1. Framed and plastic protective diagrammatic layout of all piping systems, identifying and locating piping, equipment, and valves.
2. Metal tags identifying major valves, piping system components and equipment.

PART 3 - EXECUTION

3.1 EQUIPMENT IDENTIFICATION

A. Provide nameplates to identify all specified equipment with letters and numbers matching equipment designation as indicated on the drawings.

B. Nameplates shall be fastened by use of stainless steel sheet metal screws.

C. Where equipment does not have a location for mounting of a nameplate, provide a stencil identification.

D. Stencils shall be made with a color which stands out against the equipment finish color. Stencils shall be a minimum of 2" high.

E. Apply one coat of lacquer or varnish over the stencils for protection.

F. Nameplates and stencils shall be applied after any field painting of equipment.

3.2 ADJUSTING AND CLEANING

A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.

B. Cleaning: Clean face of identification devices and glass frames of valve charts.

END OF SECTION 21 20 10

SECTION 21 21 11
ELECTRIC VERTICAL IN-LINE FIRE PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications complement the requirements of this Section.

1.2 SCOPE

A. Extent of fire pump and accessories work required by this Section is indicated on drawings and schedules, and by requirements of this Section.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 SUBMITTALS

A. Shop Drawings:

1. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

2. Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.

3. Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loading, required clearances, piping schematic drawings showing all components and methods of assembly of components.

4. Furnish pump operating characteristics, including the design operating point (flow vs. head) plotted on the pump’s operating curve. Also include brake horsepower, operating amperage, minimum non-overloading horsepower, motor RPM, and impellor size.

5. Furnish a copy of the manufacturer’s certified pump test characteristic curve.

6. Provide power, signal, and system control wiring diagrams showing all system components. Include written sequence of how the system operates and all safeties.

7. Product Certificates: For each type of fire pump and fire-pump controller, signed by product manufacturer.

8. Source quality-control test reports.

9. Field quality-control test reports.

B. Operation and Maintenance Data:

1. Operation and Maintenance Data: For fire pumps and drivers, pressure-maintenance pumps, controllers, accessories and specialties, alarm panels, and flowmeter systems to include in emergency, operation, and maintenance manuals.

2. Include parts lists for each type of pump and accessory; including "trouble-shooting" maintenance guide.

C. Tests and Reports

1. Furnish a copy of the Suction Piping Flush Report for each pump, as specified elsewhere in these specifications

2. Furnish a copy of the Hydrostatic Test for each pump, as specified elsewhere in these specifications

3. Furnish a copy of the Field Acceptance Test for each pump, as specified elsewhere in these specifications

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fire pumps and system components through one source from a single manufacturer.

B. HI Compliance: Design, manufacture, and install fire pumps in accordance with HI - "Hydraulic Institute Standards."

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

D. UL Compliance:

1. Comply with UL 778 for motor-operated water pumps.

2. UL 448

3. Provide electric motors and components which are listed and labeled by Underwriters Laboratories

E. NEMA Compliance:

1. Provide electric motors and components which comply with NEMA standards.

F. FM Approval:

1. Pumps and accessories shall be FM approved.

G. Local Requirements Compliance:

1. Comply with standards of authorities having jurisdiction pertaining to materials, hose threads, and installation.

H. NFPA Compliance:

1. Design and installation of fire pumps and accessories shall comply with the NFPA 20 - Installation of Stationary Pumps for fire pumps, drivers, controllers, accessories, and their installation and NFPA 24 - Private Fire Service Mains.

I. Design Criteria:

1. The Drawings indicate sizes, profiles, connections, and dimensional requirements of fire pumps, and are based on the specific manufacturer types and models indicated. Pumps having equal performance characteristics by other named manufacturers may be considered, provided deviations in dimensions and profiles and efficiencies do not change the design concept or intended performance as judged by the Engineer.

J. Product Options:

1. Drawings indicate size, profiles, and dimensional requirements of fire pumps, pressure-maintenance pumps, and controllers and are based on specific systems indicated. Refer to Division 01 Section "Product Requirements."

K. Factory Testing

1. Pumps shall be factory-assembled and –tested to verify compliance with minimum scheduled performance requirements

1.5 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Maintain protective covers for fire pumps electronic control panels and components during storage and throughout construction.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter. Retain protective covers for flanges and protective coatings during storage

E. Comply with pump manufacturer's written rigging instructions.

1.6 EXTRA MATERIALS

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

1. Mechanical Seals: Provide two mechanical seals for each pump.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Subject to compliance with requirements, provide fire pumps as manufactured by one of the following manufacturers specified:

1. A-C Pump; ITT Industries.
2. Armstrong Darling, Inc.
3. Aurora Pump; Pentair Pump Group.
4. Fairbanks Morse; Pentair Pump Group.
5. Paco Pumps, Inc.
6. Patterson Pump Company.
7. Reddy-Buffaloes Pump Co.
8. Sterling Peerless Pump; Sterling Fluid Systems Group.

2.2 DESCRIPTION

A. Factory assembled and tested, centrifugal in-line pump.

B. The pump shall conform to the requirements of NFPA 20, be UL listed and FM approved, and suitable for electric motor drive.

C. Pumps shall be capable of furnishing not less than 150 percent of rated capacity at not less than 65 percent of total rated head and with shutoff head limited to 140 percent of total rated head.

2.3 PUMP RATINGS

A. Pump shall be rated for 125-psig minimum working pressure

B. Pump shall be rated for a continuous water temperature of up to 250 °F.

C. Speed: Same as driver.

2.4 IMPELLOR HOUSING

A. Cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, and threaded companion-flange connections.

B. Inlet and Outlet Flangees: machined to ASME B16.1, Class 125 dimensions, unless otherwise indicated.

C. Relief Valve Size: Furnished and sized specific to the pump by the pump manufacturer

2.5 IMPELLER

A. ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.

B. Construction to match fire pump.

C. The pump and driver shall be vertically mounted with the shaft close coupled to a bronze impeller.

2.6 PUMP SHAFT AND SLEEVE

A. Steel with bronze sleeve or stainless steel.

2.7 COUPLING

A. Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.

2.8 MECHANICAL SEAL

A. Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

B. Include water slinger on shaft between motor and seal.

C. Pump will be packed with one packing gland and 5 rings of high speed graphite packing.

2.9 SHAFT BEARINGS

A. Wear Rings: Replaceable, bronze.

B. Grease-lubricated ball bearings in cast-iron housing.

2.10 MOTOR

A. Acceptable Manufacturers:

1. Emerson; U.S. Electrical Motors.

2. Lincoln Electric Company (The).

3. Marathon Electric, Inc.

B. Single speed, with permanently lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing.

C. Motor shall be UL-listed, NEMA MG 1 part 31, open-drip proof, squirrel-cage, induction motor complying with NFPA 20 and NFPA 70.

D. Motor shall be rated for continuous duty and shall be inverter rated, for use with a variable speed controller.\

2.11 FINSISH

A. Manufacturer's standard factory-applied red paint.

2.12 NAMEPLATE

A. Complete with capacities, characteristics, and other pertinent data.

2.13 FIRE PUMP ACCESSORIES AND SPECIALTIES

A. Pump manufacturer to supply the following fittings in accordance with NFPA 20, concentric discharge increaser, hose header, hose valves with caps and chains, suction control valve.

B. Pump will include a 2" hand-hole clean out, per NFPA 20, on bottom of pump. Pump manufacturers without a hand-hole clean out will supply a strainer for mounting in the suction of the pump.

C. Match fire-pump suction and discharge ratings as required for fire-pump capacity rating. Include the following:

1. Automatic air-release valve.
2. Circulation relief valve.
3. Suction and discharge pressure gages.
4. Eccentric-tapered reducer at suction inlet.
5. Concentric-tapered reducer at discharge outlet.
6. Ball Drip Valve: UL 1726.

2.14 GROUT

A. Description: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

2.15 SOURCE QUALITY CONTROL

A. Test and inspect fire pumps with their controllers according to NFPA 20 for certified shop tests.

B. Verification of Performance: Rate fire pumps according to requirements indicated.

2.16 CONTROLLER

A. The electric motor controller shall conform to the requirements of NFPA 20 and be specifically approved for fire pump service.

B. All control equipment shall be mounted on a drip proof moisture resistant housing and shall be labeled fire pump controller.

C. The control equipment shall be completely assembled, wired, and factory tested.

D. The starter shall be soft starter method panel

E. The controller shall be combined manual and automatic controller and shall automatically start the pump when the system pressure drops 10 PSI lower than the jockey pump setting. The circuit breaker shall be rated for 100,000 AIC at 208 volts.

2.17 AUTOMATIC TRANSFER SWITCH

A. The automatic transfer switch shall be an integral part of the main controller. The transfer switch shall be suitable for use with a second utility.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

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

3.2 CONCRETE BASES

A. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.3 COORDINATION

A. Coordinate size and location of fire pumps and accessories with the General Contractor.

B. Coordinate concrete support pads, including location and type of cast in place anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

3.4 INSTALLATION

A. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

C. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.

1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.

2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

D. Install and align fire pump according to NFPA 20.

E. Install suction and discharge piping equal to or greater than diameter of fire-pump nozzles.

F. Install valves that are same size as piping connecting fire pumps, bypasses, test headers, and other piping systems.

G. Install pressure gages on fire-pump suction and discharge at pressure-gage tappings.

H. Install piping accessories, hangers and supports, anchors, valves, meters and gages, and equipment supports..

I. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.

3.5 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting and leveling on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.

B. Comply with pump and coupling manufacturers' written instructions.

C. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

D. Align piping connections.

E. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

3.6 CONNECTIONS

A. Piping:

1. Piping installation requirements are specified in other Division 21 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to machine to allow service and maintenance.
3. Connect piping to pumps.
4. Install suction and discharge pipe sizes per drawings, but not less than the diameter of the intake and discharge connections to the pump impellor housing.
5. Install check valve, spool piece, and shutoff throttling valve on discharge side of pumps.
6. Install suction diffuser venturi fitting, reducing elbow (where applicable), Y-strainer, and shutoff valve on suction side of pumps.
7. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
8. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.

B. Electrical:

1. Install electrical connections for power, controls, and devices.
2. Ground equipment according to Division 26 requirements.
3. Connect wiring according to Division 26 requirements.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

1. Complete installation and startup checks according to manufacturer's written instructions.

B. Perform field tests for each fire pump when installation is complete. Comply with operating instructions and procedures in NFPA 20 to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment that cannot be satisfactorily corrected or that does not perform as indicated, then retest to demonstrate compliance. Verify that each fire pump performs as indicated.

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

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Final Checks before Startup: Perform the following preventive-maintenance operations and checks:

a. Lubricate oil-lubrication-type bearings.
b. Remove grease-lubrication-type bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer's written instructions.
c. Disconnect coupling and check electric motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
d. Verify that pump is free to rotate by hand. If pump is bound or if it drags even slightly, do not operate until cause of trouble is determined and corrected.
e. Check piping connections for tightness.
f. Clean strainers on suction piping.

3. Starting procedure for pumps is as follows:
    a. Prime pump by opening suction valve and closing drains, and prepare pump for operation.
    b. Open sealing-liquid supply valves if pump is so fitted.
    c. Start motor.
    d. Open discharge valve slowly.
    e. Observe leakage from stuffing boxes and adjust sealing-liquid valve for proper flow to ensure lubrication of packing. Do not tighten gland immediately, but let packing run in before reducing leakage through stuffing boxes.
    f. Check general mechanical operation of pump and motor.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.8 DEMONSTRATION

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

END OF SECTION 21 21 11

SECTION 21 21 20
ELECTRIC VERTICAL MULTI-STAGE JOCKEY PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications complement the requirements of this Section.

1.2 SCOPE

A. Extent of jockey pump and accessories work required by this Section is indicated on drawings and schedules, and by requirements of this Section.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 SUBMITTALS

A. Shop Drawings:

1. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

2. Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.

3. Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loading, required clearances, piping schematic drawings showing all components and methods of assembly of components.

4. Furnish pump operating characteristics, including the design operating point (flow vs. head) plotted on the pump’s operating curve. Also include brake horsepower, operating amperage, minimum non-overloading horsepower, motor RPM, and impellor size.

5. Provide power, signal, and system control wiring diagrams showing all system components. Include written sequence of how the system operates and all safeties.

6. Product Certificates: For each type of fire pump and fire-pump controller, signed by product manufacturer.

7. Source quality-control test reports.

8. Field quality-control test reports.

B. Operation and Maintenance Data:

1. Operation and Maintenance Data: For fire pumps and drivers, pressure-maintenance pumps, controllers, accessories and specialties, alarm panels, and flowmeter systems to include in emergency, operation, and maintenance manuals.

2. Include parts lists for each type of pump and accessory; including "trouble-shooting" maintenance guide.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fire pumps and system components through one source from a single manufacturer.

B. HI Compliance: Design, manufacture, and install fire pumps in accordance with HI - "Hydraulic Institute Standards."

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

D. UL Compliance:

1. Comply with UL 778 for motor-operated water pumps.

2. UL 448

3. Provide electric motors and components which are listed and labeled by Underwriters Laboratories

E. NEMA Compliance:

1. Provide electric motors and components which comply with NEMA standards.

F. FM Approval:

1. Pumps and accessories shall be FM approved.

G. Local Requirements Compliance:

1. Comply with standards of authorities having jurisdiction pertaining to materials, hose threads, and installation.

H. NFPA Compliance:

1. Design and installation of fire pumps and accessories shall comply with the NFPA 20 - Installation of Stationary Pumps for fire pumps, drivers, controllers, accessories, and their installation and NFPA 24 - Private Fire Service Mains.

I. Design Criteria:

1. The Drawings indicate sizes, profiles, connections, and dimensional requirements of fire pumps, and are based on the specific manufacturer types and models indicated. Pumps having equal performance characteristics by other named manufacturers may be considered, provided deviations in dimensions and profiles and efficiencies do not change the design concept or intended performance as judged by the Engineer.

J. Product Options:

1. Drawings indicate size, profiles, and dimensional requirements of fire pumps, pressure-maintenance pumps, and controllers and are based on specific systems indicated. Refer to Division 01 Section "Product Requirements."

K. Factory Testing

1. Pumps shall be factory-assembled and –tested to verify compliance with minimum scheduled performance requirements

1.5 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Maintain protective covers for fire pumps electronic control panels and components during storage and throughout construction.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter. Retain protective covers for flanges and protective coatings during storage

E. Comply with pump manufacturer's written rigging instructions.

1.6 COORDINATION

A. Coordinate size and location of fire pumps and accessories with the General Contractor.

B. Coordinate concrete support pads, including location and type of cast in place anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.7 EXTRA MATERIALS

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

1. Mechanical Seals: Provide two mechanical seals for each pump.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Subject to compliance with requirements, provide fire pumps as manufactured by one of the following manufacturers specified:

1. A-C Pump; ITT Industries.
2. Aurora Pump; Pentair Pump Group.
3. Crane Pumps & Systems, Inc.
4. Fairbanks Morse; Pentair Pump Group.
5. Grundfos Pumps Corp.
6. Jacuzzi Brothers.
7. Paco Pumps, Inc.
8. Sterling Peerless Pump; Sterling Fluid Systems Group.
9. Taco, Inc.

2.2 DESCRIPTION

A. Factory assembled and tested, centrifugal, direct drive, vertical multi-stage pump.

B. Multiple-impeller type complying with HI 1.1-1.2 and HI 1.3 requirements for multistage centrifugal pumps.

C. Include pump base.

D. Pressure-Maintenance Pumps, General: Factory-assembled and -tested pumps with electric-motor driver, controller, and accessories and specialties. Include cast-iron or stainless-steel casing and bronze or stainless-steel impellers, mechanical seals, and suction and discharge flanges machined to ASME B16.1, Class 125 dimensions unless Class 250 flanges are indicated and except that connections may be threaded in sizes where flanges are not available.

2.3 PUMP RATINGS

A. Pump shall be rated for 360-psig maximum working pressure

B. Pump shall be rated for a continuous water temperature of up to 250 °F.

2.4 IMPELLOR HOUSING

A. AISI 304 stainless stell

B. Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, and threaded companion-flange connections.

2.5 IMPELLER

A. AISI 304 stainless steel; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.

2.6 PUMP SHAFT

A. AISI type 316 stainless steel

B. Six-spline square edge

C. Keyed for direct connection to motor shaft

2.7 MECHANICAL SEAL

A. Silicon/Carbon/Viton mechanical shaft seal.

B. O-rings between intermediate casings shall provide positive sealing.

2.8 PUMP BEARINGS

A. Permanently lubricated tungsten carbide ball bearings.

2.9 MOTOR

A. Acceptable Manufacturers:

1. Emerson; U.S. Electrical Motors.

2. Lincoln Electric Company (The).

3. Marathon Electric, Inc.

B. Motor shall be NEMA MG 1, open-dripproof, squirrel-cage, induction motor complying with NFPA 20 and NFPA 70.

C. Motor shall be single speed, with permanently lubricated ball bearings

D. Include wiring compatible with controller used.

2.10 PIPE FLANGES

A. Furnish with minimum 250 psi ANSI 4-bolt flanges on pump inlet and discharge

2.11 FINISH

A. Manufacturer's standard color paint shall be factory applied to pump before shipping.

2.12 NAMEPLATE

A. Complete with capacity, characteristics, and other pertinent data.

2.13 ACCESSORIES AND SPECIALTIES

A. Match pressure-maintenance-pump suction and discharge ratings as required for pump capacity rating. Include the following:

1. Circulation relief valve.

2. Suction and discharge pressure gages.

2.14 GROUT

A. Description: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.

2. Design Mix: 5000-psi, 28-day compressive strength.

2.15 SOURCE QUALITY CONTROL

A. Test and inspect fire pumps with their controllers according to NFPA 20 for certified shop tests.

B. Verification of Performance: Rate fire pumps according to requirements indicated.

2.16 CONTROLS

A. The pump shall operate automatically by utilizing a controller capable of automatic starting and stopping the pump through use of a pressure switch.

B. The controller shall contain an across-the-line starter with a fusible disconnect switch, adjustable pressure switch, H-O-A selector switch, control circuit transformer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

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

3.2 CONCRETE BASES

A. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.3 INSTALLATION

A. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

C. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.

1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.

2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

D. Install and align fire pump according to NFPA 20.

E. Install suction and discharge piping equal to or greater than diameter of fire-pump nozzles.

F. Install valves that are same size as piping connecting fire pumps, bypasses, test headers, and other piping systems.

G. Install pressure gages on fire-pump suction and discharge at pressure-gage tappings.

H. Install piping accessories, hangers and supports, anchors, valves, meters and gages, and equipment supports..

I. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.

3.4 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting and leveling on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.

B. Comply with pump and coupling manufacturers' written instructions.

C. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

D. Align piping connections.

E. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

3.5 CONNECTIONS

A. Piping:

1. Piping installation requirements are specified in other Division 21 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

2. Install piping adjacent to machine to allow service and maintenance.

3. Connect piping to pumps.

4. Install suction and discharge pipe sizes per drawings, but not less than the diameter of the intake and discharge connections to the pump impellor housing.

5. Install check valve, spool piece, and shutoff throttling valve on discharge side of pumps.

6. Install suction diffuser venturi fitting, reducing elbow (where applicable), Y-strainer, and shutoff valve on suction side of pumps.

7. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

8. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.

B. Electrical:

1. Install electrical connections for power, controls, and devices.

2. Ground equipment according to Division 26 requirements.

3. Connect wiring according to Division 26 requirements.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

1. Complete installation and startup checks according to manufacturer's written instructions.

B. Perform field tests for each fire pump when installation is complete. Comply with operating instructions and procedures in NFPA 20 to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment that cannot be satisfactorily corrected or that does not perform as indicated, then retest to demonstrate compliance. Verify that each fire pump performs as indicated.

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

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Final Checks before Startup: Perform the following preventive-maintenance operations and checks:
    a. Lubricate oil-lubrication-type bearings.
    b. Remove grease-lubrication-type bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer's written instructions.
    c. Disconnect coupling and check electric motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
    d. Verify that pump is free to rotate by hand. If pump is bound or if it drags even slightly, do not operate until cause of trouble is determined and corrected.
    e. Check piping connections for tightness.
    f. Clean strainers on suction piping.
3. Starting procedure for pumps is as follows:
    a. Prime pump by opening suction valve and closing drains, and prepare pump for operation.
    b. Open sealing-liquid supply valves if pump is so fitted.
    c. Start motor.
    d. Open discharge valve slowly.
    e. Observe leakage from stuffing boxes and adjust sealing-liquid valve for proper flow to ensure lubrication of packing. Do not tighten gland immediately, but let packing run in before reducing leakage through stuffing boxes.
    f. Check general mechanical operation of pump and motor.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.7 DEMONSTRATION

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

END OF SECTION 21 21 20

SECTION 21 22 10
DOUBLE DETECTOR CHECK BACKFLOW PREVENTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies double detector check valves and includes materials, general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. Comply with all requirements of ASSE 1015, ASSE 1048 and AWWA C510 Standards – as applicable.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 21 01 10.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide double detector check assembly as manufactured by one of the following:

1. Conbraco
2. Febco
3. Hersey
4. Watts
5. Wilkins

2.2 GENERAL

A. Double detector check assembly shall consist of two (2) independently operating check valves, two shutoff valves and four testcocks.

B. Double detector check assemblies shall be rated 175 PSI MWWP (33 °-140 °F max working temperature), and shall be factory assembled and tested to assure proper mainline/bypass balance and cross-over performance.

C. Head loss through the assembly shall not exceed 8 PSI at velocities from 0 to 7.5 FPS. Flow curves shall be documented by independent laboratory testing.

D. All materials of construction shall be lead-free.

2.3 CHECK VALVES

A. Mainline check assemblies shall be of the spring loaded center stem guided type. Guides at the seat ring and at the cover shall be replaceable non-corrosive bushings.

B. All internal metal parts included in the mainline check assemblies shall be of series 300 stainless steel and shall not contain any dissimilar metals. Body may be of cast iron with interior lining complying with AWWA C550.

C. Elastomeric seat discs must be reversible, seat rings shall be B-61 bronze or series 300 stainless steel, bolted to the valve bodies with an "O" ring seal.

D. Check valve bodies and covers shall be manufactured of ductile iron according to ASTM A536, Grade 65-45 and shall be designed to withstand a 10-1 safety factor over rated MWWP.

2.4 SHUT-OFF VALVES

A. Mainline shutoff valves shall be resilient wedge. OS&Y, UL/FM for fireline service and are considered integral to the assembly along with full port bronze ball valve test cocks.

B. Provide tamper switches on each shut off valve.

2.5 FLANGES

A. Flanges shall be in accordance with ANSI B15.1, Class 125.

2.6 FINISH

A. Ductile iron bodies shall be epoxy coated internally 10-20 mils and prime coated externally.

2.7 DETECTOR

A. The by-pass meter assembly shall consist primarily of a bronze water meter in series with a bronze double check valve.

B. All low flow demands up to a minimum of 3 gpm (0.189 L/s) are to pass through the by-pass meter and meter-size double check valve assembly and be accurately recorded. All flows above that of 3 gpm will pass through both the line-size double check valve assembly and by-pas without accurate registration by or damage to the meter.

C. Meter shall be a 5/8" x 3/4" totalizing meter with flow range that registers in gallons or cubic feet as required by the local water department.

PART 3 - EXECUTION

3.1 GENERAL

A. Furnish all labor, construction equipment and materials necessary for the complete installation of the double detector check valve assemblies as indicated. All work shall be in strict compliance with all governing state and local code requirements, in full conformity with the best current trade practices and subject to approval of the Architect or his Representative.

B. See other Division 21 sections for purging, cleaning and disinfection requirements.

3.2 BACKFLOW PREVENTER INSTALLATION

A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of water, plumbing and health departments and authorities having jurisdiction.

B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.

C. Do not install bypass piping around backflow preventers.

D. Support backflow preventers, valves, and piping from wall or floor and on brick or concrete piers.

E. Wire tamper switches on shutoff valves back to fire alarm system.

END OF SECTION 21 22 10

SECTION 21 25 20
FIRE DEPARTMENT SIAMESE CONNECTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies fire department backfeed connections, and includes general descriptions and installation methods.

B. Furnish all labor, construction equipment and materials necessary for the complete installation of fire department backfeed connections as indicated.

C. All work shall be in strict compliance with all governing state and local code requirements, in full conformity with the best current trade practices and subject to approval of the Architect or his Representative

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. Manufacturer shall be regularly engaged in manufacturer of fire department backfeed connections of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 CODES AND STANDARDS

A. Regulatory Requirements: Comply with requirements of the following codes:

1. NFPA and OBC compliance: Install fire protection systems in accordance with NFPA 13 "Standard for the Installation of "Sprinkler Systems" and all OBC requirements.

2. UL Compliance: Fire protection system materials and components shall be Underwriter's Laboratories listed and approved for the application anticipated.

3. Water Department/Fire Department/Marshall Compliance: Furnish and install fire protection systems on accordance with regulations required by local Water Department, Fire Department, and Fire Marshal.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for fire department backfeed connections. Submit schedule indicating manufacturer's figure number, size, location, rated capacities, and features for each fire department backfeed connection.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weights, required clearances, and method of assembly of components.

C. Maintenance Data: Submit maintenance data and spare parts lists for wall mounted storz fire department backfeed connections. Include this data, product data, and shop drawings in maintenance manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide double detector check assembly as manufactured by one of the following:

1. Guardian Fire Equipment, Inc.
2. Crocker
3. American Fire Hose and Cabinet, Inc.

2.2 GENERAL

A. Furnish fire department connections as indicated on the drawings.

B. Wall-Type, fire department connections shall be UL 405

2.3 MATERIALS AND RATINGS

A. Fire department Connection body shall be 175-psig minimum pressure rating.

B. Valve body shall be constructed with corrosion-resistant polished brass body with brass inlets, brass wall escutcheon plate, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections.

C. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate

2.4 IDENTIFICATION

A. Furnish identification plate with marking similar to “AUTO SPKR & STANDPIPE.”

B. Type: Flush mounted, square or rectangular plate.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which fire protection specialties are to be installed.

B. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 FIRE DEPARTMENT CONNECTION INSTALLATION

A. All work details not covered in these Specifications shall be governed by the requirements of the latest edition of NFPA.

B. Install wall-type, fire department connections in vertical wall.

C. Install ball drip valve at each check valve for fire department connection.

D. Locate all fire department backfeed connection not more than four feet above grade. Consult the local Fire Department for final mounting position of backfeed connection

E. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.

F. Install alarm devices in piping systems.

3.3 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Connect water-supply piping to fire-suppression piping. Include backflow preventer between potable-water piping and fire-suppression piping.

D. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.

E. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.

F. Connect alarm devices to fire alarm.

3.4 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and NFPA 14.

3.5 FIELD QUALITY CONTROL

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

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Flush, test, and inspect sprinkler systems according to NFPA 13 and NFPA 14, "Systems Acceptance" Chapter.

4. Coordinate with fire alarm tests. Operate as required.

5. Coordinate with fire-pump tests. Operate as required.

6. Verify that equipment hose threads are same as local fire department equipment.

B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.6 CLEANING AND PROTECTION

A. Clean dirt and debris from wall mounted storz fore department backfeed connections.

END OF SECTION 21 25 20

SECTION 21 31 10
SPRINKLER HEADS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies sprinklers and includes materials, specialties, and basic installation instructions. Portions of this Section may not be required in this project.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. Provide Automatic Sprinklers with heat-responsive element complying with the following:

1. UL 199, for nonresidential applications.

2. UL 1626, for residential applications.

3. UL 1767, for early-suppression, fast-response applications.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 21 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 21 04 40.

1.5 DELIVERY, STORAGE, HANDLING

A. Store all sprinklers and materials on site or off site to avoid damage due to construction and activity and weather.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. AFAC Inc.

B. Central Sprinkler Corp.

C. Firematic Sprinkler Devices, Inc.

D. Globe Fire Sprinkler Corporation.

E. Grinnell Fire Protection.

F. Reliable Automatic Sprinkler Co., Inc.

G. Star Sprinkler Inc.

H. Venus Fire Protection, Ltd.

I. Victaulic Co. of America.

J. Viking Corp.

2.2 LOCATIONS AND FINISHES

A. Sprinkler types and exposed materials shall be in accordance with Table 21 31 10.1 below:

Table 21 31 10.1

Location	Sprinkler Head Type	Finish
Utility Rooms and Spaces without a ceiling	Upright	Chrome Plated or Plain Brass or Painted
Gymnasiums and locker/shower rooms without a ceiling	Upright	Plain Brass or Chrome Plated with Wire Guard or Painted
See Plans	Sidewall	Chrome Plated or Plain Brass or Painted
See Plans	Pendent	Chrome Plated or Plain Brass or Painted
See Plans	Recessed-Pendant	Chrome Plated or Plain Brass or Painted
See Plans	Concealed-Recessed	Chrome Plated or Brass Plated or Painted

2.3 SPRINKLERS

A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Sprinklers shall have 250-psig minimum pressure rating if sprinklers are components of high-pressure piping system.

B. The sprinkler operating mechanism shall be a frangible glass bulb which contains a heat responsive liquid. During a fire, the ambient temperature rises causing the liquid in the bulb to expand. When the ambient temperature reaches the rated temperature of the sprinkler, the bulb shatters, and the waterway is cleared of all sealing parts and water is discharged towards the deflector. The deflector is designed to distribute the water in a pattern that is most effective in controlling the fire.

C. Sprinklers shall have Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless required by application.

D. Sprinkler Escutcheons and cover plates: Provide materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers shall be listed with sprinkler assembly.

2.4 FLEX-HEAD SPRINKLERS

A. An option to the final hard-pipe connection to the sprinkler head shall be flexible braided stainless steel hose with structural support assembly in compliance with UL, FM, and NFPA 13 requirements.

B. Flex-head sprinkler assemblies shall be as manufactured by one of the following:

1. Easy Flex
2. Flexhead Industries (Atkore International)
3. Sprinkflex
4. Victaulic Vicflex

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install sprinkler heads according to NFPA 13 and as required by the Applicable Building Code.

3.2 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels and tiles.

B. Sprinkler heads in corridors shall be centered between the corridor walls. All other heads in the finished spaces with ceilings shall be located within 6" of the ceiling grid.

C. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

3.3 FIELD QUALITY CONTROL

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

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.4 EXTRA MATERIALS

A. Valve Wrenches: Furnish to Owner, 2 valve wrenches for each type of sprinkler head installed.

B. Sprinklers and Cabinets: Furnish six (6) extra sprinklers of each style included in the project. Furnish each site with its own sprinkler head cabinet and special wrenches as specified in this section.

C. Obtain receipt from Owner that extra stock has been received and give the Architect/Engineer a copy of this receipt.

END OF SECTION 21 31 10

SECTION 21 32 10
FLOW AND TAMPER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications compliment the requirements of this Section.

1.2 SCOPE

A. This Section specifies fire protection system alarm initiating devices, and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of alarm devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Provide fire protection alarm devices of same type by same manufacturer.

1.4 CODES AND STANDARDS

A. Regulatory Requirements: Comply with requirements of the following codes:

1. UL Compliance: Fire protection system materials and components shall be Underwriter's Laboratories listed and approved for the application anticipated.

2. System shall meet all I.R.I requirements.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of fire protection specialty. Include pressure drop curve or chart for each type and size of fire protection specialty. Submit schedule indicating manufacturer's figure number, size, location, rated capacities, and features for each required fire protection specialty.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weights, required clearances, and method of assembly of components.

C. Maintenance Data: Submit maintenance data and spare parts lists for each type of fire protection specialty. Include this data, product data, and shop drawings in maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL

A. Alarm-device types shall match piping and equipment connections.

2.2 WATER FLOW INDICATOR

A. UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

B. Manufacturers:

1. ADT Security Services, Inc.
2. Grinnell Fire Protection.
3. ITT McDonnell & Miller.
4. Potter Electric Signal Company.
5. System Sensor.
6. Viking Corp.
7. Watts Industries, Inc.; Water Products Div.

2.3 VALVE SUPERVISORY "TAMPER" SWITCH

A. UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

B. Manufacturers:

1. McWane, Inc.; Kennedy Valve Div.
2. Potter Electric Signal Company.
3. System Sensor.

PART 3 - EXECUTION

3.1 GENERAL

A. Furnish all labor, construction equipment and materials necessary for the complete installation of the fire protection system specialties as indicated. All work shall be in strict compliance with all governing state and local code requirements, in full conformity with the best current trade practices and subject to approval of the Architect or his Representative.

3.2 EXAMINATION

A. Examine areas and conditions under which fire protection specialties are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.3 INSTALLATION

A. All work details not covered in these Specifications shall be governed by the requirements of the latest edition of NFPA.

B. Install alarm devices in piping systems.

3.4 CONNECTIONS

A. Drawings indicate general arrangement of piping.

B. Install devices in piping or in valves to allow service and maintenance.

C. Electrical Connection: Wiring is specified in Division 26.

D. Connect alarm devices to fire alarm.

E. Ground equipment according to Division 26 requirements.

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and NFPA 14 and Specification Section 21 12 10.

3.6 FIELD QUALITY CONTROL

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

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

2. Energize circuits to electrical equipment and devices.

3. Coordinate with fire alarm tests. Operate as required.

4. Verify that equipment hose threads are same as local fire department equipment.

B. Report test results promptly and in writing to the Architect and authorities having jurisdiction.

END OF SECTION 21 32 10

SECTION 22 00 10
DOCUMENT INTERPRETATION AND GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section. Contractors and Subcontractors shall examine Architectural, Structural, Electrical and all other Drawings and Specifications pertinent to this project. The above mentioned Drawings and Specifications for all the Divisions are part of the Contract Documents.

1.2 SCOPE

A. This Section specifies the basic requirements for mechanical installations and includes requirements common to more than one section of Division 22. It expands and supplements the requirements specified in sections of Division 1.

B. Drawings and Specifications are to be considered as supplementing each other. Work specified but not shown, or shown but not specified, shall be performed or furnished as though mentioned in both Specifications and Drawings.

C. This section describes the requirements for demolition of plumbing equipment, materials, and systems and defines equipment and material salvage rights.

D. This Section specifies requirements of Codes and Standards to which this project must conform.

1.3 INFERRED PHRASES

A. Where the words “submit”, “submitted”, “approval”, or “approved” or similar are used without an object of the verb, the phrase shall be assumed to read: “Submit to the Construction Manager”, “Submitted to the Construction Manager”, or “Approved by the Construction Manager” as appropriate, unless otherwise noted.

B. The word “provide” shall be understood to mean “furnish and install”.

C. The word “set” shall be understood to mean “install”.

D. Reference is made within these Specifications and on the drawings to “General Contractor”. There is no “General Contractor” on this project per se. There is a Construction Manager on this project. It shall be understood that all references to “General Contractor” shall mean the Trade Contractor assigned by the Construction Manager to perform the work.

1.4 PERMITS

A. Unless noted otherwise, this Contractor shall secure and pay for all permits and certificates of inspection required for the work under this Division.

B. Deliver all certificates and official records of approval, by governing agencies, to the Architect.

1.5 CODES

A. Reference to the codes and standards listed shall constitute the minimum acceptable requirements. Nothing in the Specifications shall be construed to permit deviation from the requirements of the governing code. Where requirements of the Drawings and Specifications exceed those of the code listed, follow the Drawings and Specifications.

B. The scope of work shall include the furnishing of systems, equipment and materials specified in this division and as called for on the Drawings. Work shall include supervision, operations, methods and labor for the fabrication, installation, start-up and tests for the complete installation.

C. Install work in full accordance with rules and regulations of State, County and City authorities having jurisdiction over premises. This shall include safety requirements of the State of Ohio Division of Industrial Relations and OSHA.

D. All wiring shall be in compliance with the current edition of the National Electric Code, Applicable State Code, Applicable local (city) Code and OSHA. In cases of conflict between code and specifications, the more restrictive requirements shall govern.

E. All equipment, materials and installation methods shall comply with the following, where applicable:

1. Building Officials and Code Administrators International (BOCA)
2. Codes and Standards Association (CSA)
3. International Building Code (IBC)
4. International Mechanical Code (IMC)
5. National Building Code of Canada (NBC)
6. National Electric Code (NEC)
7. National Fire Protection Association (NFPA)
8. National Pressure Vessel Code
9. Ohio Building Code (OBC)
10. Ohio Plumbing Code (OPC)
11. International Association of Plumbing and Mechanical Officials (IAPMO)
12. Standard Building Codes (SBC)
13. Standard Mechanical Codes (SMC)
14. Uniform Building Codes (UBC)
15. Uniform Mechanical Codes (UMC)

1.6 STANDARDS

A. All equipment, materials and installation methods shall comply with the following, where applicable.

1. Air Conditioning and Refrigeration Institute (ARI)
2. Air Conditioning, Heating, Refrigeration Institute (AHRI)
3. American National Standards Institute (ANSI)
4. American Society for Testing and Materials (ASTM)
5. American Society of Mechanical Engineers (ASME)
6. American Society of Sanitary Engineering (ASSE)
7. American Water Works Association (AWWA)
8. American Welding Society (AWS)
9. Cast Iron Soil Pipe Institute (CISPI)
10. Fluid Sealing Association (FSA)
11. National Institute of Standards and Technology (NIST)
12. National Pressure Vessel Code
13. National Sanitation Foundation (NSF)

14. National Science Foundation (NSF)
15. Plastic Pipe Institute (PPI)
16. Underwriter's Laboratories of Canada (ULC)
17. Underwriters Laboratories, Inc. (UL)

1.7 DESIGN DRAWINGS

A. The Contract Drawings, as submitted, are diagrammatic and are not intended to show exact location of equipment and piping unless dimensions are given. Equipment and piping are to be installed along the general plans shown on the Drawings, but keeping in mind actual building conditions.

B. Because of the scale of the drawings, certain basic items may not be shown, but where such items are required by other Sections of these specifications or where they are required by the nature of the work, they shall be furnished and installed. Rough-in dimensions and locations shall be verified with the supplier of all equipment furnished by other trades or by the Owner prior to the time of roughing-in.

C. All equipment, piping and material specified hereinafter as shown on the Drawings shall be furnished and installed by this Contractor, unless specifically indicated to the contrary.

D. If this Contractor proposes to install equipment requiring space conditions other than those as specified and/or shown on the Contract Drawings, or to rearrange the equipment, he shall assume full responsibility and expense for the rearrangement of the space and shall obtain the full approval of the Architect before proceeding with the work.

E. This Contractor shall locate all equipment that must be serviced, operated or maintained in fully accessible positions. Minor deviations from the Contract Drawings may be made to allow for better accessibility, but changes of magnitude, or which involve extra cost, shall not be made without approval. Ample space shall be allowed for removal of all parts that may require replacement or service in the future.

F. The Drawings and the Specifications are cooperative and supplementary. It is the intent of both said Drawings and Specifications to cover all plumbing requirements in their entirety as nearly as possible. This Contractor shall closely check the Drawings and Specifications for any obvious errors or omissions, and bring any such condition to the attention of the Architect prior to the receipt of bids, in order to permit clarification by means of an Addendum. If there is no question prior to the bid proposal date, the Architect shall assume that the Drawings and Specifications are complete and correct and will expect the intent of said documents to be complied with, and the installation to be complete in all respects according to said intent.

G. This Contractor shall have a complete set of drawings including Architectural, Structural, Mechanical and Electrical drawings on the site at all times. Prior to installing any of his work, this Contractor shall check the drawings for exact dimensions and see that his work does not interfere with clearance required for beams, foundations, finished columns, pilasters, conduits, partitions, piping, ductwork, etc., as shown on the drawings and details. After work is installed, if interferences develop that have not been called to the attention of the Architect before the installation, this Contractor shall, at his own expense, make such changes in his work as directed by the Architect.

H. Extra costs which might result from deviations from the Drawings, so as to avoid interferences, shall be considered a "Job Condition", and no additional compensation will be considered applicable. In the event that such interferences occur in the course of the Work, due to an error, omission, or oversight by the Contractor, no additional compensation shall be allowed. Interferences which may occur during the course of construction shall be brought to the immediate attention of the Architect, and his/her decision, confirmed in writing, shall be final.

1.8 EXAMINATION OF SITE

A. Before submitting a bid, it is recommended that each Contractor visit the site and become familiar with conditions affecting this work. No additional payment will be made on claims that arise from lack of knowledge of existing conditions.

1.9 BASIS OF DESIGN

A. Where more than one manufacturer is listed in the Specifications as being acceptable, it shall be understood that the "basis of design" manufacturer is the manufacturer included in the equipment schedule or with the model number listed. Subject to project requirements, all other listed manufacturers are considered as acceptable alternatives. If installation of an acceptable alternative alters the design, electrical or space requirements indicated on the Drawings, this Contractor shall bear the costs for the revised design and construction including costs of all trades involved.

1.10 EQUIPMENT AND MATERIALS

A. Prior to the signing of the Contract, the successful bidder may be required to submit to the Architect a list of manufacturers of the major items of equipment he proposes to furnish and the names of any subcontractors he proposes to employ.

B. When two or more items of same equipment type are required (plumbing fixtures, valves, etc.) they shall be of the same manufacturer.

C. All equipment and materials shall be new.

D. Provide material and labor which is neither drawn nor specified but which is obviously a component part of and necessary to complete work and which is customarily a part of work of similar character.

1.11 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of equipment, of types and sizes required whose products have been in satisfactory use in similar service for not less than 3 years.

1.12 COORDINATION AND SUPERVISION

A. This Contractor shall examine the work of other trades and shall so coordinate and schedule work as not to cause delays or interference with work of others.

B. Determine sizes and locations of structural openings necessary for the installation of plumbing systems. Coordinate these openings and the setting of sleeves with other trades, to accomplish the installation of fixtures, equipment and piping with minimal cutting through concrete or masonry.

C. Coordinate the installation of all required supporting devices, inserts and hangers in structural components as they are constructed.

D. Install plumbing equipment and components (valves, etc.) to facilitate servicing, maintenance and repair or replacement. Coordinate the final location of concealed equipment and components requiring access with the final location of access doors and panels. Allow adequate space for proper servicing, maintenance and repair. Make final connections to equipment with consideration for future disconnection and removal with minimal interference with other installations.

E. Where installation is to occur in an area with no ceiling and mounting heights are not detailed or dimensioned on the Drawings, install equipment components and systems to provide maximum possible headroom.

F. Install additional piping offsets as required to obtain maximum headroom or to avoid conflicts with other work, without additional cost to the Owner.

G. Before installing work, report any interferences between work of this Division and work of other Divisions to the Architect as soon as they are discovered. The Architect shall determine which work must be relocated, or make adjustments to maintain clearances and required headroom and to avoid conflict with other work. If any work is installed so that the Architectural design cannot be adhered to, this Contractor is liable for cost of making such changes as the Architect may require.

H. Ceiling grid systems shall not be supported from equipment or piping and vice versa. Where interferences occur, in order to support piping, ceiling grid systems, etc., trapeze type hangers or supports shall be employed which shall be located so as not to interfere with access to plumbing equipment such as valves, etc.

I. Provide adequate competent supervision at all times when work is being performed. Cooperate with all other trades to avoid interferences and delays.

1.13 PROTECTION OF WORK AND PROPERTY

A. The Contractor shall be responsible for safeguarding work, property and facilities against damage, both his own as well as others, with which he may come into contact in the performance of his work.

B. Stored materials shall be protected against damage from weather. Pipe openings shall be closed with caps or plugs during installation. All fixtures and equipment shall be covered and protected from damage. Any materials or equipment damaged at any stage in the construction shall be replaced or repaired and shall be in a clean, unblemished condition at project turnover.

C. Protect floors and walls against staining and abrasion from chips and cutting oil where pipe cutting and threading machines are used.

D. Protect equipment and finished surfaces from soldering and brazing with baffles and blankets.

E. Use drop cloths to protect finished surfaces from paint and insulation adhesive droppings.

1.14 DELIVERY, STORAGE AND HANDLING

A. This Contractor shall pay all costs for the transportation of materials and equipment, included in this contract, to the job site.

B. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels and other information needed for identification.

C. Each Contractor shall make provisions for the delivery and safe storage of his materials and equipment in coordination with the work of others. Materials and equipment shall be delivered at such stages of the work as will expedite the work as a whole and shall be marked and stored in such a way as to be easily checked and inspected.

1.15 CLEAN-UP

A. Refer to Division 1 for general requirements for final cleaning.

B. Insofar as this Division is concerned, at all times keep premises and building in a neat and orderly condition follow explicitly any instructions of the Architect in regard to storing of materials, protective measures, cleaning-up of debris, etc.

C. Upon completion of work remove all tools, equipment, surplus materials, etc. from the project site.

D. Prior to project turn-over thoroughly clean all piping, fixtures, and equipment, removing all dirt, grease, oil and dust. It is recommended that steps are taken to eliminate this dust buildup during construction.

1.16 DAMAGE AND EMERGENCY REPAIRS

A. Assume responsibility for any damage caused by leaks in the piping system being installed or reworked under this Contract. Repair all damage without extra cost to the Owner. Restore building, piping, insulation etc. to their original condition.

B. The Owner reserves the right to make emergency repairs as required to keep equipment in operation, without voiding Contractor's guarantee or relieving him of responsibility during warranty period.

1.17 WARRANTIES

A. This Contractor shall warrant for a period of one year (from the date of final acceptance) that all work and equipment will remain free from all defects in workmanship and materials, and that it will comply with all the specific requirements of the Specifications and other Contract Documents governing the work.

B. All work found by the Architect to be defective will be replaced with new work meeting all the requirements of the Contract. This Contractor will bear all costs of supplying such new work, and installing and finishing same, and will assume all costs for replacing other work damaged by the removal and replacement of any of the work.

C. Include copies of all warranties in the operation and maintenance manuals.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Examine areas and conditions where equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

B. Install equipment as indicated, and in accordance with manufacturer's installation instructions. Uncrate units and inspect for damage. Verify that nameplate data corresponds with unit designation.

C. Locate equipment, plumb and level, firmly anchored in locations indicated. Coordinate with other trades to assure correct recess size for recessed units. Hang ceiling units from building substrate, not from piping. Support units with rod-type hangers anchored to building subtrate.

D. All equipment shall be installed with adequate clearance provided for routine maintenance and servicing. Locate horizontal, above-ceiling units to maintain access with ceiling components below.

3.2 ELECTRICAL WIRING

A. General: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electric Installer.

1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 Sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

3.3 DAMAGE AND EMERGENCY REPAIRS

A. Assume responsibility for any damage caused by leaks in the piping system being reworked under this Contract. Repair all damage without extra cost to Owner. Restore building, piping, insulation etc. to their original condition.

B. Owner reserves the right to make emergency repairs as required to keep equipment in operation, without voiding Contractor's guarantee or relieving him of responsibility during warranty period.

3.4 ADJUSTING AND CLEANING

A. General: After construction is complete, including painting, clean all equipment exposed surfaces.

B. Retouch any marred or scratched surfaces of factory-finish, using finish materials furnished by the manufacturer.

END OF SECTION 22 00 10

SECTION 22 00 90
LEED REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes the general requirements for LEED related construction requirements to be performed by this division's contactor under this project's contract.

1.3 CODES AND STANDARDS

A. LEED v4 for BD+C: Schools

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 10.

C. Submit documentation outlined below to the Engineer for LEED construction credit submittal

1.5 ABBREVIATIONS

A. GPC - Gallons per cycle

B. GPF - Gallons per flush

C. GPM - Gallons per minute

D. VOC - Volatile organic compound

PART 2 - PRODUCTS

2.1 WATER EFFICIENCY (WE)

A. WE Prerequisite 1 and WE Credit 3 – Water Use Reduction

1. Furnish and install plumbing fixtures of exact model (or approved equal) and performance as scheduled on the design drawings.

2. Plumbing fixtures listed in the following tables shall, at minimum, meet the indicated performance.

Table 22 00 90.1

Flush Fixture Type	Minimum Flow Rate
Commercial Urinal	1.0 gpf
Dual Flush Water Closets	1.6/1.1 gpf
High Efficiency Urinal	0.5 gpf
High Efficiency Water Closets (Gravity Flush)	1.28 gpf

Table 22 00 90.2

Flow Fixture Type	Minimum Flow Rate
Commercial Pre-Rinse Spray Valves	≤1.6 gpm
Kitchen Sink	2.2 gpm
Public Lavatory Faucets (Infrared)	0.5 gpm
Public Lavatory Faucets (Metering)	0.25 gpc
Shower	2.5 gpm

3. The following plumbing fixtures are exempt from the requirements of WE Prerequisite 1 and WE Credit 3.
   a. Commercial Steam Cookers, Dishwashers, and Ice Makers
   b. Clothes Washers
   c. Janitor/Mop Basins

2.2 ENERGY AND ATMOSPHERE (EA)

A. EA Prerequisites Credit – Minimum/Optimize Energy Performance

1. Furnish and install service hot water heating equipment of exact model (or approved equal) and performance as scheduled on the design drawings.
2. Service hot water heating equipment shall meet the minimum efficiency requirements as outlined in ASHRAE Standard 90.1-2007 Chapter 7.

B. EA Credit – Advanced Energy Metering

1. Furnish and install domestic water and natural gas sub-meters as indicated on the design drawings.

2.3 INDOOR ENVIRONMENTAL QUALITY (IEQ)

A. IEQ Credit - Low-Emitting Materials

1. Aerosol adhesives must comply with the Green Seal Standard for Commercial Adhesives GS-36 requirements.
2. Provide plumbing adhesives and sealants conforming to the minimum VOC requirements of this credit as outlined in the following schedule.

Table 22 00 90.3

Application	VOC Limit (g/L less water)
ABS Welding	325
Adhesive Primer for Plastic	550
Caulking and Sealants	420 max
Contact Adhesive	80
CPVC Welding	490

Application	VOC Limit (g/L less water)
Plastic Cement Welding	250
PVC Welding	510
Special Purpose Contact Adhesive	250

PART 3 - EXECUTION

3.1 GENERAL

A. This building is to be a LEED (Leadership in Energy and Environmental Design) certified building, **Silver** standard.

B. This contractor shall provide all manpower required to meet the LEED credit requirements outlined in the Division 1 specification section "LEED REQUIREMENTS."

C. Perform the testing and certification requirements outlined in this section unless specifically indicated to be performed by another party.

D. Assist the Commissioning Agent in his required duties to ensure all construction related requirements are met and documented.

3.2 WE PREREQUISITES AND CREDITS – WATER USE REDUCTION

A. Adjust sink and lavatory faucet's infrared metering device to meet scheduled maximum flow rates.

B. Adjust shower discharge to meet scheduled maximum flow rates

C. Adjust water closet infrared flushometer to meet scheduled maximum flow per flush.

3.3 EA PREREQUISITE - FUNDAMENTAL COMMISSIONING

A. Assist the Commissioning Agent to perform his required duties.

B. Provide a representative of the Mechanical Contractor familiar with all building systems and equipment installed to assist the Commissioning Agent during the system testing phase of commissioning.

C. Provide a representative of the Temperature Controls Contractor and the Balance Contractors familiar with all building systems and equipment installed to assist the Commissioning Agent during the system testing phase of commissioning.

3.4 EA CREDIT – ADVANCED ENERGY METERING

A. Provide all sensors and measurement devices as indicated on the drawings for data collection to verify compliance with this credit's requirements.

B. Provide dedicated temperature controls graphics to catalog and display necessary data. See division 23 for further details.

3.5 IEQ CREDIT – CONSTRUCTION INDOOR AIR QUALITY MANAGEMENT PLAN

A. During construction, the following practices shall be implemented, photographed, observed, recorded, and reported to the engineer on a bi-weekly basis by this contractor:

B. Equipment Protection

1. Check and seal all leaks in the flue vents for domestic hot water heaters. Do not store construction or waste materials in any mechanical rooms.

C. Source Control

1. Exhaust pollution sources to the outside through an available exhaust system or portable fans to the outside.
2. Keep lids on containers of wet products or waste material.
3. Keep solvent-containing rags in closed, flame-proof containers.
4. Locate the storage of pollutant sources outside the range of occupied areas.
5. Apply sealers to surfaces with persistent odors.

D. Housekeeping

1. Control dust with wetting agents or sweeping compounds and use efficient duct collection methods. Floors shall be free of excess duct and construction material waste at the end of each day.
2. Keep all surfaces clean (including inside mechanical equipment).
3. Remove spills or excessive applications of solvent-containing products as soon as possible.
4. Keep site as dry as possible and remove accumulated water.
5. Use a HEPA filter in vacuum cleaners to prevent the aerolization of settled dust.
6. Cover all absorptive materials from moisture damage.

E. Scheduling

1. Sequence the installation of materials to avoid contamination of absorptive materials such as insulation, carpeting, ceiling tile and gypsum wallboard.

END OF SECTION 22 00 90

SECTION 22 01 10
PROJECT SUBMITTAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section contains:

1. General requirements and procedures for Submittals and Shop Drawings.

2. Requirements for Operation and Maintenance Manuals (O&M manuals) for all Division 22 work.

3. Requirements for record drawings for documentation of installed conditions for all Division 22 work.

B. For specific requirements, see individual specification sections.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Where applicable, the Contractor shall submit:

1. Shop Drawings

2. Operation and Maintenance Manuals

3. Piping System Integrity Test Reports

4. Start-up Reports

5. Record Drawings

6. Factory Tests

B. A list of required submittals are specified in each individual specification section.

3.2 SUBMITTAL PROCEDURES

A. Shop drawings

1. Contractor Review

a. This Contractor shall review, stamp and sign with approval all submittals and deliver with reasonable promptness and in orderly sequence so as to cause no delay in the work or in the work of any other Contractor.

b. Submission of shop drawings without review, signature, and approval shall be cause for rejection. Such submittals shall be returned without review.

c. If the submittal includes deviations from the requirements of the Contract Documents, the Contractor shall clearly note the deviations "in red" on the submittal.

2. Electronic Submission

a. All submittals shall be in electronic format. Electronic submittals shall conform to this specification.

b. Electronic submittals shall conform to the following requirements:

1). Electronic submittals shall be in Portable Document Format (.pdf)

a). Electronic submittals shall include a transmittal.

b). All portions of the electronic submittal shall be bound in a single .pdf file.

c). File shall be named to match submittal name as it appears on the individual specification.

i. Example: "22 17 30 - Strainers".

d). Submittals shall specifically identify any deviations from the Contract Documents.

2). Electronic submittals shall include a Contractor review stamp that indicates review and approval by the Contractor prior to submission.

3). Electronic submittals shall be transmitted via an e-mail:

a). Provide only one submittal per e-mail

b). E-mail subject line shall clearly indicate:

i. Project name

ii. That the e-mail contains a submittal

iii. Contents of submittal

c. Failure to conform the requirements above may result in rejection.

d. At the Reviewer's discretion, the Reviewer has the option to return the submittals in whatever method is most convenient or appropriate for the Project.

3. Shop Drawing Cover Form

a. All submittals shall include a Cover form.

b. Follow the Architects requirements for the cover form.

c. Cover form shall contain, at a minimum, the following information:

1). Submitting Contractors Contact information

2). Shop Drawing Number and Name (As noted in Project Submittal Requirements)

3). Issue (Original, Resubmittal 1, etc.)

4). Name of equipment manufacturer

5). Name of equipment supplier

d. If the submittal includes deviations from the requirements of the Contract Documents, the Contractor shall clearly indicate such deviations on the shop drawings cover form.

4. Engineer's Review

a. Shop drawings shall be reviewed only for general compliance and not for dimensions or quantities. The Reviewer will make reasonable efforts to detect and correct errors, omissions and inaccuracies but shall not be responsible for failure to detect errors, omissions, or inaccuracies. Failure to detect errors, omissions and

inaccuracies shall not relieve the Contractor of responsibility for the proper and complete installation in accordance with the intent of the Contract Documents.

b. The Engineer shall mark the shop drawings in one of the ways outlined below. See each description for interpretation of Engineers marks and Contractor responsibilities associated with each.

1). APPROVED: The submittal complies with the requirements of the specifications.

2). APPROVED AS NOTED: The submittal generally complies with the requirements of the specifications but some non-critical items which need to be corrected/coordinated are noted. The corrections shall be changed on the shop drawings submitted for inclusion in the Operations and Maintenance Manual. Re-submittal is not required unless noted otherwise.

3). REVISE AND RESUBMIT: The submittal generally complies with the requirements of the specifications but some critical items which need to be corrected/coordinated are noted. The submittal must be revised and resubmitted with all comments addressed.

4). REJECTED: The submittal does not comply with the requirements of the specifications. The submittal must be revised and resubmitted.

c. Approval of submittal items shall not eliminate the Engineers right to reject those items if defects are discovered prior to final acceptance of the completed work.

B. Operations and Maintenance Manual

1. Submit one (1) copy of the Division 22 manual to the Architect/Engineer for review.

2. After review, address Architect/Engineer's comments and provide the Owner with three (3) hardbound copies of the final approved operating and maintenance manuals for Division 22. Obtain receipt. Note – Operation and Maintenance manuals are required before Owner training takes place.

C. Record Drawings

1. Submit a complete set of red-lined drawings indicating "as-installed" locations of piping, ductwork, and equipment.

3.3 SHOP DRAWING CONTENT

A. Indicate specific options or accessories on shop drawings by pointing to, checking off, or underlining. Do not use highlighter.

B. Do not reproduce Contract Documents or copy standard information as the basis of shop drawings. Standard information prepared without specific reference to the Project is not considered shop drawings and will be cause for rejection.

C. Shop Drawings shall contain the following information, where applicable.

1. General:

a. Model Number

b. Dimensions

c. Weight

d. Clearance requirements

e. Special rigging requirements

f. Material

g. Color and finish
h. Installation recommendations
i. Ratings
j. All included options and accessories

2. Performance:
   a. Performance data as scheduled and/or specified (at a minimum)
   b. Code/standard compliance information
   c. Pressure drop curve or chart
3. Connections:
   a. All pipe and duct connections, including:
      1). Size(s)
      2). Location(s)
      3). Connection service (Supply, return, exhaust, etc.)
      4). Connection method
   b. Electrical connections:
      1). Location(s)
      2). Termination lug size(s)
      3). Plug NEMA configuration
4. Electrical:
   a. Characteristics, including:
      1). Voltage/Phase
      2). Full load and locked rotor amps
      3). Required overcurrent protection and short circuit interrupting capacity
      4). Horsepower of motor(s)
   b. Power wiring diagram
   c. Accessories furnished, including starter(s), disconnect(s), on/off switches, etc.
      1). Clearly indicate if accessories are factory or field mounted/wired.
5. Controls:
   a. Wiring terminations for required interlock and control wiring
   b. Wiring diagram, with factory installed and field installed portions clearly differentiated.
   c. Accessories furnished, including thermostat(s), sensor(s), etc.
      1). Clearly indicate if accessories are factory or field mounted/wired.
   d. Sequences of operation
   e. Integration
      1). Protocol(s), including baud rate.
      2). Available points, with read/write capabilities clearly noted.

3). Registers required for integration.

6. Refer to individual specifications sections for special required information.

3.4 OPERATOR AND MAINTENACE MANUAL FORMAT

A. Binder:

1. Include all materials in a three (3) ring binder or binders, if volume of content dictates multiple books.

2. Provide a type-written cover for the binder indicating project title, contractor firm name and address, date of substantial completion (project finish date), and owner company name.

B. Index:

1. Include a numbered index indicating ALL documents included in the manual.

C. References:

1. Include a page or pages indicating contractor firm name, address, and contact phone number.

2. Indicate the contractor's job foreman, including contact phone number and email address.

3. Indicate all subcontractors utilized, including contact phone numbers and email addresses for each.

4. Name of service agency and installer. Include 24 hour per day emergency phone numbers.

5. Include design Architect reference, including contact phone numbers.

6. Include design Engineer reference.

D. Contents:

1. Provide a separate tabbed section for each specified item type including the following, if applicable:

a. Identification, name, mark, or number as indicated on the design drawings.

b. Final accepted shop drawing, including Engineer's cover form indicating "Accepted" without exception.

c. Manufacturer's maintenance and service manuals including instructions for troubleshooting, disassembly, repair, reassembly, adjusting, aligning, servicing and lubrication.

d. Spare/replacement parts list.

e. Belt sizes, type and lengths (where applicable).

f. Step by step procedures for startup and shutdown of each system and piece of equipment.

g. Copy of equipment start-up report and/or capacity test (if required as part of equipment specification). See Equipment and System Start-up specification section for requirements.

h. Equipment manufacturer's warranty.

2. Automatic controls including device schedules, diagrams and written sequence of operations.

3. Final accepted balance reports as required by this specification.

4. Copy of all system integrity verification report, where required. See Piping Systems Flushing and Testing specification section for requirements.
5. Copy of all piping system flushing, cleaning, and certification reports as required by this Specification.
6. Copy of testing, adjusting, and balancing report as required by this division specification.
7. Copy of Ductwork leakage testing report as required by this division specification.

E. Warranties

1. Contractor warranty including date of final acceptance (this indicates the start of the warranty period).
2. Date of final acceptance shall be issued by the Architect.

F. Electronic Requirements

1. Provide Operations and Maintenance Manuals to Owner and Engineer in .pdf format.

3.5 RECORD DRAWINGS

A. Field Documentation

1. This Contractor shall record all changes from original design drawings made during installation. These changes shall be recorded in red ink on a dedicated copy of the final approved construction or coordination drawings. Changes shall be accurately dimensioned and/or drawn to scale.
2. This Contractor shall keep an updated set of prints, including changes, on the job site at all times and shall submit one (1) set of updated and legible "as-built" prints to the Architect when the work is complete.
3. Prepare record documents in accordance with the requirements in Division 1.
4. In addition to the requirements specified in Division 1, indicate the following installed conditions.
    a. Ductwork mains and branches and locations of balancing dampers, motor operated dampers, control devices, coils, etc.
    b. Piping mains and branches and locations of isolation valves, balance valves, control valves, regulating valves, strainers, expansion devices or loops, air vents, etc.
    c. Locations of all equipment.
    d. Locations of all equipment controllers, control panels, sensors, control devices, etc.
    e. Locations, inverts, and sizes of all underground piping and power.
5. Record documents shall include all deviations from the Contract Documents including any substitutions.
6. If the project requires the preparation of coordination drawings, the coordination drawings shall be submitted as record documents.

END OF SECTION 22 01 10

SECTION 22 01 30
COORDINATION DRAWINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes the requirements for coordination of all trades prior to installation of building systems and the requirements of deliverable coordination drawing sets.

B. Provide pre-construction coordination of all trades and coordination drawings as described in this section.

1.3 SUBMITTALS

A. Provide coordination drawings as herein specified.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. The Division 23 contractor shall be the lead coordination contractor. The Division 22 contractor shall prepare coordination drawings for the required Division 22 systems as outlined below and shall provide the drawings in the specified electronic format to the Division 23 contractor for final inclusion in the overall coordination drawings.

B. The Division 22 contractor shall assist the Division 23 contractor in the preparation and coordination of Division 22 systems and shall make all requested and required changes, within reason.

C. Prepare coordination drawings in accordance with Division 1 Section "Project Coordination" and for all areas of the building as follows:

1. Above all ceilings and in all interstitial spaces.

2. For all Mechanical Equipment Rooms and other areas where mechanical and plumbing equipment is installed.

3. For all areas where careful coordination is needed for installation of products for and materials fabricated by separate entities.

D. Secure approval of coordination drawings from other trades affected, prior to submittal to the Architect for review. Each trade must indicate acceptance of illustrated conditions by attaching his endorsement to each drawing.

E. Proceed with installation only after review of coordination drawings by the Architect and Engineer and approval from other trades affected.

F. Plan the development of coordination drawings with the General Contractor’s schedule for work.

1. At the beginning of construction, submit a coordination drawing development schedule including an anticipated drawing list for development tracking.

2. It is anticipated and acceptable for the contractor to submit coordination drawings based on the progression of the work areas identified in the project schedule.

G. This Contractor shall keep a set of signed off coordination drawings, including updated changes, on the job site at all times and shall submit one (1) set of updated and legible "as-built" prints to the Architect when the work is complete.

1. Record any adjustments from original signed-off coordination drawings that were made during the final installation of the work. These shall be recorded in red ink on the prints. Changes shall be accurately dimensioned and/or drawn to scale.

2. Final marked coordination drawings shall be submitted as record documents.

3.2 DRAWING FORMAT

A. Furnish all drawings in AutoCAD 2019 or later or Autodesk Revit 2019 or later, and as agreed upon by all contractors prior to the commencement of coordination efforts.

B. Scale: ¼”=1’-0” minimum

C. Final drawings shall be submitted as hard copy color prints as a shop drawing for review and approval by the Architect and Engineer.

D. Trades and/or systems shall be assigned a separate color for easy distinction. Colors shall be assigned to all supporting Divisions by the Division 23 contractor.

3.3 RESTRICTIONS

A. Photocopied, reproduced or traced drawings of the original Contract Documents shall not be used as coordination drawings.

B. Electronic files of the original Contract Drawings will not be allowed to be used as coordination drawings.

3.4 REQUIRED SYSTEMS

A. Piping and Equipment

1. Sanitary and Vent

2. Storm

3. Domestic water

4. Medical gas

5. Natural gas

6. Controls

3.5 REQUIRED CONTENT

A. Quantities, dimensions and locations of equipment connections for piping, ductwork and electrical systems shall be verified with equipment suppliers and included in the preparation of coordination drawings.

B. Show relation of all items of heating, ventilating and air conditioning equipment, ductwork and piping, plumbing equipment and piping and fire protection equipment and piping. Indicate all electrical devices that affect location of heating, ventilating, air conditioning and plumbing equipment, piping, ductwork and air inlets or outlets. Field measure and show existing items affecting new installation in remodeled areas. Questions and interferences shall be indicated on the coordination drawings for clarification by the Architect and Engineer. If there are not questions and interferences indicated on the coordination drawings, the Engineer and Architect shall assume that the drawings and specifications are complete and correct and will expect the intent of said documents to be complied with, and the installation to be complete in all respects according to said intent.

C. Indicate location of all access panels required and coordinate type and location with General Trades.

D. For Equipment Rooms and areas, coordination drawings shall show, but are not limited to the following:

1. Floor drains and concrete housekeeping pads.

2. All equipment, plumbing work and work of other trades, including floor supports and ceiling suspension systems showing manufacturers recommend installation requirements.

3. All access areas around all equipment with clearances noted from floor to underside of mechanical and other trades work.

4. All clear floor areas required for removal and cleaning of coils, filters, tubes, etc.

E. Include all pertinent temperature control sensor locations, panel locations, power, network wiring, low voltage wiring, etc. that are required for interfacing and monitoring of plumbing equipment as indicated on the design drawings and/or described herein in the Division 22 specifications.

F. Provide a coordinated set of wiring diagrams for motors, equipment items and temperature control showing line diagrams, power diagrams and terminal connections to ensure proper operation specified. Include provisions to accommodate equipment that is specified as an acceptable alternative from equipment that is the "Specified Standard" so that, if the acceptable alternative is installed, there will be no change in the Contract Sum.

G. Secure from other trades (i.e., mechanical, structural, acoustical ceilings, fire protection, electrical, etc.) any information necessary for the development of coordination drawings. This information shall include, but is not limited to the following:

1. Structural steel and slab layouts and details.

2. Framing and suspension details for ceilings.

3. Framing and suspension details for equipment suspended from structure above.

4. Location and size of electrical pull boxes, conduit, buss ducts, cable trays, lighting fixtures, etc.

5. Location and size of transformers, switchgear, and motor control centers, pneumatic transport tubes, etc.

H. Existing Conditions

1. Any existing pipe or equipment which will impact routing and layout of new work (such as existing storm drains and sanitary/vent piping), shall be field measured by this Contractor and shown on coordination drawings.

3.6 PHASING

A. This project is broken into multiple phases of work. Spaces surrounding phased work areas are to remain occupied during construction. Many of these phases require demolition of and alterations to plumbing, and medical gas systems within the phased work area that affect surrounding areas outside of the phased work area. temporary piping to areas outside of each phased work areas shall be shown on coordination drawings to allow those areas to remain occupied during construction.

END OF SECTION 22 01 30

SECTION 22 02 10
OWNER OPERATING AND MAINTENANCE TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes the general requirements for the purpose of operations and maintenance training of the Owner's facility personnel on the systems and equipment installed or modified under this project's contract.

B. Provide training to the Owner's designated personnel for all equipment and systems listed herein. Individual specification sections indicate the number of training hours required.

1.3 SUBMITTALS

A. Submit to the Architect a schedule of all training sessions, topics to be covered, times, and attending personnel at least fourteen (14) days prior to the first session.

B. Submit to the Architect a sign-in sheet from each training session, with all attending personnel, including contractor's training personnel and manufacturer's representatives, and the date, number of hours, and time of the training session.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Prior to acceptance of the work and after all equipment is in operation, provide to the Owner instructions for the purpose of training the Owner's personnel in all phases of operation and maintenance of equipment and systems provided under this Division.

B. Contractor shall furnish the necessary trained personnel to perform the demonstrations and instruction, and shall arrange to have the manufacturer's representatives present to assist with the demonstrations where specified.

C. Operation and maintenance manuals shall be provided to the owner at least fourteen (14) days prior to the first training session.

3.2 TRAINING REQUIREMENTS

A. The demonstrations shall consist of not less than the following:

1. Point out the actual location of each component of a system and demonstrate its function and its relationship to other components within the system.

2. Demonstrate each system by actual "start-stop" operation showing how to work controls, how to reset protective devices, how to replace components requiring regular maintenance, and what to do in an emergency.

3. Demonstrate communication, signal, alarm and detection systems by actual operation of the systems and show how to reset signal, alarm and detection devices.

3.3 SCHEDULE AND AGENDA

A. Submit a schedule of training events, including proposed date, starting time and ending time of each training session the Architect/Engineer, Commissioning Agent and Owner prior to the completion of construction for review and approval.

B. Equipment and systems requiring a training session are indicated in each equipment and/or system's dedicated specification section.

C. Indicate required attendees and proposed trainers required for each training session with the event schedule

D. Indicate proposed training session topic, associated equipment, and rough training session agenda

3.4 COMMISSIONING AGENT

A. If the project has a Commissioning Agent, the Commissioning Agent shall be present for all training sessions, when commissioning is specified for the project.

3.5 SIGN-OFF

A. If the project has a Commissioning Agent, the Commissioning Agent shall verify completion of training sessions.

B. Owner shall verify completion of training sessions.

END OF SECTION 22 02 10

SECTION 22 03 10
PIPING SYSTEM FLUSHING AND TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies piping systems' testing and cleaning requirements common to more than one section of Division 22. Portions of this Section may not be required in this project.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all piping testing and cleaning work described in this Section.

1.3 CODES AND STANDARDS

A. All plumbing piping systems shall be tested in accordance with the applicable Plumbing Code.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 INSPECTIONS

A. Obtain all piping inspections required by the authorities having jurisdiction over premises. Furnish all certificates of such inspections and include in the Operating and Maintenance Manuals. Pay all fees necessary for the inspections.

B. No part of system shall be covered before inspection is made and approved. If covered before test, Contractor shall pay for cost of uncovering so test can be made and accepted.

3.2 TESTING - GENERAL

A. Perform piping system pressure tests to all new piping systems prior to final connections to equipment and fixtures AND prior to connection to existing building piping. If equipment or fixtures are connected, they shall be isolated from the system during the test.

B. Perform all tests before piping is concealed, insulated or heat traced.

C. Contractor is responsible for completely draining the systems after hydrostatic tests are performed. Any damage from freezing prior to acceptance of the completed installation shall be repaired at no additional cost to the Owner.

D. Correct minor leaks in welded joints by chipping out weld and re-welding. Correct leaks in screwed joints by replacing thread or fitting or both. Caulking of threaded joints is not permitted. Repair leaks in copper pipe by sweating out joints, thoroughly cleaning both pipe and fitting, and re-soldering.

E. Pressure tests shall be witnessed by Owner's representative.

3.3 WATER SUPPLY SYSTEM TESTING

A. Comply with the Ohio Plumbing Code, section 312 requirements.

B. Tests shall be made with water (hydrostatic) or air, at a required pressure for a set duration, without appreciable pressure drop.

3.4 DRAIN AND VENT TESTING

A. Comply with the Ohio Plumbing Code, section 312 requirements

3.5 BACKFLOW PREVENTION ASSEMBLY TEST

A. Test all backflow preventer assemblies per the Ohio Plumbing Code and in accordance with ASSE standards upon completion of installation or relocation.

3.6 SYSTEM CHLORINATION – POTABLE DOMESTIC WATER SYSTEMS

A. Flush the system with clean potable water until dirty water does not appear at outlets.

B. Fill with a water/chlorine solution (50ppm chlorine) and allow to stand for 24 hours.

C. Following standing time, flush the system with clean potable water until chlorine is purged from the system.

D. Repeat chlorination, if necessary, until no bacteriological contamination is present in the system.

E. Procedure shall conform to AWWA C651 and be accepted by the local health department.

END OF SECTION 22 03 10

SECTION 22 03 20
EQUIPMENT AND SYSTEM START-UP

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes equipment and systems general start-up requirements, procedures, documentation, and submission requirements. See individual specifications sections for additional requirements.

B. Furnish all materials, labor, and supervision to properly start-up equipment and systems provided under this Division and as required by this section.

1.3 SUBMITTALS

A. Include a copy of all Equipment and System Start-up Forms in the Operations and Maintenance Manuals.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SCHEDULE

A. Coordinate schedule for start-up, testing and adjustments of various equipment and systems with the Architect, other contractors and Owner.

B. Contact all parties, including the Architect, required to witness equipment start-up as indicated in each equipment and system specification section of this division. Contractor shall give at least two (2) week's notice to all parties of scheduled start-up date and time.

3.2 EXAMINATION

A. Prior to start-up verify the following:

1. That each piece of equipment or system has been checked for proper lubrication, wiring, drive rotation, belt tension, control sequence or other conditions which may cause damage.

2. That all tests, meter readings and specified electrical characteristics agree with those required by the equipment or system.

3. That each piece of equipment or system is supported properly.

4. Check equipment containing a separately coupled motor for proper motor and shaft alignment.

5. Check vibration isolation devices to verify spring locks have been removed and vibration isolators are unconstrained.

3.3 LUBRICATION AND PACKING

A. Properly lubricate all rotating or reciprocating equipment before it is started with correct grade, type and quantity of lubricant as recommended by manufacturer.

B. Check each shaft containing a packing gland condition by backing packing gland off and examining for proper grade, amount and type of packing as recommended by manufacturer.

C. Maintain all lubrication, gaskets and packing during construction. Assure that at the time of final project acceptance all are in first class condition.

3.4 CORRECTION OF DEFICIENCIES

A. Any conditions found to be unsatisfactory to the standards outlined by the manufacturer or these specifications during the cursory pre-start-up examination process shall be corrected prior to actual start-up of equipment and systems.

3.5 EQUIPMENT AND SYSTEM START-UP

A. Follow manufacturer's recommendations and requirements for start-up of equipment.

B. Document date of equipment start-up for commencement of manufacturer's warranty.

C. If required by the specific equipment or system specification section, provide the following:

1. Factory authorized personnel present at site to inspect, check and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

2. Submit a written report that equipment or system has been properly installed and is functioning correctly.

D. During the start up testing or adjustment period, maintain on the project, a contractor representative thoroughly familiar with all phases of the project for as long a period as required to start up all equipment and systems and demonstrate that they are functioning properly.

E. Contractor is responsible for furnishing any and all instruments required to start up and test equipment or systems which include thermometers, electric meters, pressure gauges, etc.

3.6 ADJUSTMENTS

A. Contactor shall make adjustments, if required, to equipment and systems after starting them up and observing them operate for a sustained period of time. Corrections shall be made if systems are excessively noisy or vibrating excessively.

B. The Engineer or his representative, may make spot checks to determine the accuracy and completeness of final adjustments. Should spot checks indicate more than a reasonable deviation from design requirements, the Contractor shall repeat tests and adjustments to the satisfaction of the Engineer.

END OF SECTION 22 03 20

SECTION 22 03 50
COMMISSIONING OF PLUMBING SYSTEMS AND COMPONENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes the general requirements for plumbing equipment and system Commissioning requirements to be performed by this division's contactor under this project's contract.

B. Commissioning work shall be a team effort to ensure that all equipment and systems have been completely and properly installed, function together correctly to meet the design intent, and document system performance.

1.3 SUBMITTALS

A. Submit completed and signed-off prefunctional checklists for record. Include a copy of the signed-off checklists in the operations and maintenance manual.

1.4 ROLES AND RESPONSIBILITIES

A. Commissioning Agent (CxA):

1. Commissioning process leader

B. Plumbing Contractor (PC):

1. Lead contractor
2. Perform Pre-functional system and equipment examination and tests.
3. Schedule verification tests for each piece of equipment and system outlined in part 3 of this specification section.
4. Schedule TCC and TAB representatives to be present on site as required for each test as outlined in part 3 of this specification section.

C. Temperature Controls Contractor (TCC):

1. Assist the CxA and PC in verification of proper system operation and compliance with design intent.
2. Compare TAB system measurements to temperature control system's permanent measuring device outputs. Adjust devices to align sensor measurements with TAB measurements.

D. Testing, Adjusting, and Balancing Contractor (TAB):

1. Assist the CxA and PC in verification of proper system operation and compliance with design intent.
2. Verify, during the CxA witnessed equipment and system performance tests, system operation by independent measurement of system pressures, temperatures, flow rates, and electrical currents. Note, the temperature control system may NOT be utilized for verification.

1.5 REQUIRED SYSTEMS AND EQUIPMENT

A. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems, and sub- systems. The following equipment and systems shall be included:

1. Domestic Hot Water Plant (Water heater, recirculation pump, etc.).

2. Building automation system and controls, including control board and interface with systems and equipment provided in other Divisions.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Provide access to measurement equipment for the following parameters:

1. Water Pressure

2. Water Temperature

3. Water Flow

4. Electrical Current

2.2 TEST EQUIPMENT – PROPRIETARY

A. Where water flow measurements are required for system verification but no permanent flow measuring devices are installed in the piping system, the contractor shall provide other means of flow measurement such as ultrasonic measuring devices.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall complete all phases of work so the systems can be started, tested, balanced, and commissioning procedures undertaken. This includes the complete installation of all equipment, materials, fixtures, pipe, valves, wire, insulation, controls, etc., per the contract documents and related directives, clarifications, and change orders.

B. The CxA shall be responsible for coordinating and directing each step of the commissioning process.

C. A commissioning plan shall be developed by the CxA. The Contractor shall assist the CxA in preparing the commissioning plan by providing all necessary information pertaining to the actual equipment and installation. If Contractor initiated system changes have been made that alter the commissioning process, the CxA shall notify the Owner.

D. Acceptance procedures are normally intended to begin prior to completion of a system and/or sub-systems, and shall be coordinated with the Division 22 subcontractor. Start of acceptance procedures before system completion does not relieve the Contractor from completing those systems as per the schedule.

E. Attendance is required at a mandatory kick-off meeting by all commissioning team members. Kick-off meeting shall be held at a time and place designated by the Owner. The purpose shall be to familiarize all parties with the commissioning process, and to ensure that the responsibilities of each party are clearly understood.

3.2 EQUIPMENT AND SYSTEM START-UP

A. The CxA shall be informed of all equipment and system start-ups.

B. See dedicated equipment start-up specification section of this division.

3.3 PREFUNCTIONAL CHECKLISTS

A. Pre-functional checklists are comprised of a full range of checks and tests to determine that all components, equipment, systems, and interfaces between systems operate in accordance with contract documents. These checks and tests shall be completed by the Division 22 contractor and sub-contractors and documented using pre- functional checklists.

B. The PC shall complete prefunctional checklists for each piece of equipment and/or system. Sample forms are attached to this section, but the PC is permitted to use their own if desired.

C. Systems must be balanced prior to completion of prefunctional testing.

D. Final verification witnessed by the CxA shall not be scheduled until a signed, completed copy of the prefunctional checklist is submitted to the CxA by the PC.

3.4 FINAL TESTING AND VERIFICATION

A. Detailed testing shall be performed on all installed equipment and systems to ensure that operation and performance conform to contract documents. The following testing is required as part of the commissioning process:

1. Functional performance tests (FPT) shall determine if the Plumbing system is operating in accordance with the design intent. This includes all operating modes, interlocks, control responses, and specific responses to abnormal or emergency conditions. FPT shall be done by Contractor as "Contractor directed" testing and then tested again during CxA witnessed testing.

2. Integrated Systems Testing (ISTs) shall determine if the Plumbing systems are operating in accordance with the design intent, specifically where the Plumbing systems have an interface with other building systems, such as the BAS, electrical, plumbing, etc. This includes all operating modes, interlocks, control responses, and specific responses to abnormal or emergency conditions. ISTs shall be done by Contractor as "Contractor directed" testing and then tested again during CxA witnessed testing.

B. The PC shall submit requests for the CxA perform final witnessed FPT’s and IST’s for each system and piece of equipment. The PC shall give a minimum of one (1) week’s notice when scheduling CxA presence for witness testing.

3.5 CORRECTIVE ACTION AND RETESTING

A. In some systems, maladjustments, misapplied equipment, and/or deficient performance under varying loads will result in additional work being required to commission the systems. This work shall be completed under the direction of the Owner, with input from the Contractor, equipment supplier, and CA. Whereas all members shall have input and the opportunity to discuss, debate, and work out problems, the Owner shall have final jurisdiction over any additional work done to achieve performance.

B. Corrective work shall be completed in a timely fashion to permit the completion of the commissioning process. Experimentation to demonstrate system performance may be permitted. If the CxA deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the CxA shall notify the Owner, indicating the nature of the problem, expected steps to be taken, and suggested deadline(s) for completion of activities. If the deadline(s) pass without resolution of the problem, the Owner reserves the right to obtain supplementary services and/or equipment to resolve the problem. Costs incurred to solve the problems in an expeditious manner shall be the Contractor's responsibility.

C. The PC is allowed one witnessed re-test without incurring additional costs associated with CxA participation. If systems are not operating properly at the time of the second witness test, the contractor shall correct unsatisfactory condition(s) and shall be responsible for costs associated with further witness tests.

3.6 PARTICIPATION IN COMMISSIONING

A. The PC shall provide skilled personnel to start-up and debug all systems within Division 22. These same personnel shall be made available to assist the CxA in completing the commissioning program. Work schedules, time required for testing, etc., shall be requested by the CxA and coordinated by the Contractor. Contractor shall ensure that the qualified personnel are available and present during the agreed upon schedules and of sufficient duration to complete the necessary tests, adjustments, and/or problem resolutions.

B. System performance problems and discrepancies may require additional personnel time, CxA time, reconstruction of systems, and/or replacement of system components. The additional Contractor personnel time shall be made available for subsequent commissioning periods until the required system performance is obtained at no additional cost to the Owner.

C. The CxA reserves the right to question the appropriateness and qualifications of the personnel relative to each item of equipment, system, and/or sub-system. Qualifications of personnel shall include expert knowledge relative to the specific equipment involved and a willingness to work with the CxA. The PC shall provide adequate documentation and tools to start-up and test the equipment, system, and/or sub-system.

3.7 OWNER TRAINING

A. Comprehensive training of O&M personnel shall be performed by the PC, and where appropriate, by other sub-contractors, and vendors as specified elsewhere in this division. The CxA will require documentation of all training sessions prior to commissioning process close-out.

END OF SECTION 22 03 50

SECTION 22 04 20
PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies painting requirements for this division and includes descriptions of piping and equipment included as part of this division's contract and general application methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

C. Finishing (paint, wall covering, etc.) shall not be included under this Section.

PART 2 - PRODUCTS

PART 3 - PRODUCTS

3.1 GENERAL

A. Where indicated, all painted metal surfaces shall be primed and painted with an oil based paint. Apply painting to the following areas utilizing Sherwin-Williams paints indicated or an equivalent paint provided by one of the approved manufacturers:

1. Ferrous Metal (Exterior): One coat Galvite HS and two coats All Surface Alkyd Enamel.

2. Ferrous Metals (Interior): Spot prime abraded areas with All Surface Enamel Primer and two coats ProClassic Alkyd Interior Enamel.

3. Insulated Coverings: One coat Fast Drying Primer and two coats ProMar 400 Alkyd Semi-Gloss.

B. Where colors are indicated to match adjacent building finish, the Architect/Engineer shall make final color seleciton.

C. Equipment touch up painting shall match the equipment finish.

D. See Part 3 – Execution for piping, supports and equipment to be painted.

3.2 ACCEPTABLE MANUFACTURERS

A. Painting shall be done with products as manufactured by Pittsburgh Plate Glass, Sherwin-Williams, Pratt and Lambert, or Glidden.

B. Equipment touch up painting shall match the equipment finish.

PART 4 - EXECUTION

4.1 LOCATIONS REQUIRING PAINTING

A. All exterior natural gas piping above grade:

1. Color selection to match adjacent building or surroundings where exposed to public view. Final color selection shall be made by the Architect/Engineer.

B. All interior natural gas piping

1. Color shall be yellow.

C. General:

1. Exposed blacksteel iron work including, hangers, pipe, pipe covering, equipment casings or enclosures, tanks, and ductwork exterior to mechanical equipment rooms.

2. Where equipment is complete with a factory finish, additional painting is not required unless directed by the Architect/Engineer (requiring a color change).

3. "Exposed" as indicated above, shall refer to exposed to view and shall not include piping or materials concealed above ceilings, under floor slabs, or buried in walls.

4.2 INSTALLATION REQUIREMENTS

A. Materials and equipment installed under this Division shall be left free from dirt, grease and foreign matter, ready for painting.

B. No equipment or piping shall be painted before being tested.

C. Damaged surfaces of prefinished materials and equipment shall be touch-up painted to match existing finish.

D. Comply with manufacturer's recommendations for mixing and application.

E. Do not paint over name plates, labels, identification tags, signs, markers, etc.

4.3 FIELD QUALITY CONTROL

A. Provide protective drop coverings for all permanent finishes and surfaces while applying paint and until the final coating has dried to protect from excess paint spills, drips, etc.

4.4 CLEANING

A. Clean excess paint from any surfaces not meant to be painted.

B. Remove protective coverings once final paint coat has dried.

END OF SECTION 22 04 20

SECTION 22 04 30
EXCAVATING, TRENCHING, BACKFILLING, AND PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

C. Division 3 "Concrete" Specifications complement the requirements of this Section.

D. Division 3 "Asphalt" Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes excavating, trenching, backfilling and paving procedures and requirements for the proper installation of underground plumbing systems.

B. This section describes the acceptable materials and installation methods to provide housekeeping pads, curbs, rails, inertia bases, etc., for equipment furnished under this Division.

C. Furnish all equipment, materials, labor, and supervision necessary to provide cast-in-place concrete housekeeping pads, curbs, rails, inertia bases, etc., as described herein and where indicated on the drawings. Extent of plumbing related work required by this Section is indicated on drawings and/or specified in other Division 22 Sections.

D. Furnish all materials, equipment, labor, and supervision required to excavate and backfill to facilitate underground plumbing piping and utility work both inside and, where indicated, outside the building.

E. Each Contractor shall be responsible for all excavating and backfilling work required for installation of their work for this project, unless noted otherwise in this specification or on the drawings.

1.3 QUALITY ASSURANCE

A. Codes and Standards

1. Excavation Work:

a. Codes and Standards: Perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction.

b. Prior to any excavation on the site, each contractor shall provide notification to The Ohio Utilities Protection Service (800-362-2764) a "utilities protection service".

c. This Contractor shall check with the Architectural drawings concerning the test borings to determine areas of rock which should be included in his excavation work. Failure to adjust for rock conditions shall not warrant cause for additional compensation.

2. Sanitary and Storm Sewers, Gas, Water and Fire Service Mains:

a. Environmental Compliance: Comply with applicable portions of local environmental agency regulations pertaining to sanitary and storm sewage systems, gas, water and fire protection systems.

b. Utility Compliance: Comply with local utility requirements, regulations and standards pertaining to sanitary and storm sewerage systems, gas, water and fire protection systems.

1.4 COORDINATION, SEQUENCING AND SCHEDULING

A. Coordinate locations and routing of underground building sanitary and storm drainage piping, gas piping, fire protection piping and water piping.

B. Coordinate work with other utility work.

C. Coordinate the shut off and disconnection of utility services with the Owner and the utility company.

D. Notify the Architect at least 5 days prior to commencing excavation work and any disruption to existing utilities.

1.5 PROJECT CONDITIONS

A. Protect adjacent finish materials against spatter during concrete placement.

PART 2 - PRODUCTS

2.1 CONCRETE RELATED MATERIALS

A. Forms for exposed finish concrete work shall be of lumber, metal, metal-framed or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces.

1. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

2. Welded Wire Reinforcing Fabric: ASTM A 185, welded steel wire fabric.

3. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place.

2.2 CONCRETE MATERIALS

A. Materials for concrete work shall comply with requirements of Division 2 "Portland Cement Concrete Paving" Section.

B. Portland Cement: ASTM C 150, Type I.

C. Use one brand of cement throughout project, unless otherwise acceptable to Architect. Prepare design mixes for each strength of concrete indicated.

1. Fly Ash: ASTM C 618, Type C or Type F.

2. Fine Aggregate: ASTM C 33, sand.

3. Course Aggregate: ASTM C 33, crushed gravel.

2.3 DESIGN AND PROPORTIONING OF CONCRETE MIXES

A. General: Design mechanical work concrete as follows, for each 28-day compressive strength class:

1. 3000 psi Class: 500 lbs. of cement per cu. yard (5.25 sacks) and 0.46 water/cement ratio.

PART 3 - EXECUTION

3.1 PROTECTION OF BUILDING AND SITE CONDITIONS

A. Existing Utilities: Locate existing underground utilities in excavation areas. If utilities are indicated to remain, support and protect services during excavation operations.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies and Owner for shut off of services if lines are active.

C. Uncharted or Incorrectly Charted Utilities: Document actual routes for inclusion in as-built drawings. Contact Engineer and Owner if actual route of existing underground utilities requires revisions to the design.

D. Protect structures, utilities, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by excavation operations.

E. Use of explosives is not permitted.

F. Provide temporary covering or enclosure and temporary heat as necessary to protect bottoms of excavations from freezing and frost action. Do not install mechanical work on frozen excavation bases or subbases.

G. Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights. Where trenches cross roads, walks or public thoroughfares, provide suitable barricades and bridges adequately protected by signs or red flags during day and lights at night.

H. Operate warning lights as recommended by authorities having jurisdiction.

I. Site Information: Perform site survey, research public utility records and verify existing utility locations. Verify that gas, water, fire protection, sanitary and storm sewerage system piping may be installed in compliance with original design and reference standards. Subsurface conditions were investigated during the design of the project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.

3.2 EXCAVATION

A. See also Division 2, "SITE WORK".

B. Do not excavate for plumbing work until work is ready to proceed without delay so that total time lapse from excavation to completion of backfilling will be kept at a minimum.

C. Slope sides of excavations to comply with local codes and ordinances having jurisdiction. Shore and brace as required for stability of material excavated. Maintain sides and slopes of excavations in safe condition until completion of backfilling. Maintain shoring and bracing in excavations throughout time period excavations will be open. Carry down shoring and bracing as excavation progresses. Contractor is referred to the “General Conditions” which defines responsibility for damage which may be incurred in the course of excavating.

D. For deep excavation shoring and bracing, provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross braces, in good serviceable condition.

E. Establish requirements for trench shoring and bracing to comply with local codes and authorities having jurisdiction.

F. De-watering:

1. Lay no pipe in water. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area. Furnish all pumping equipment, power, temporary connections, etc. and do all pumping necessary to remove ground or casual water.

2. Do not allow water to accumulate in excavations. Remove water to prevent soil changes detrimental to stability of subgrades. Provide and maintain pumps, well points, sumps, suction and discharge lines and other de-watering system components necessary to convey water away from excavations.

3. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or run off areas. Do not use trench excavations as temporary drainage ditches.

G. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.

H. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.

I. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.

J. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of 1" diameter and larger with emulsified asphalt tree paint.

K. Trenching:

1. Excavate trenches for underground installations to exact grade and depth with only sufficient dirt removed at bell holes to provide working space. Any trenches dug below required depth shall be filled to proper depth with sand. Trenches shall not be more than 18" wider than external diameter of pipe.

2. Limit the length of open trench to that in which pipe can be installed, tested and the trench backfilled within the same day.

3. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of pipe. Provide a minimum of 6" of stone or gravel cushion between rock bearing surface and pipe.

4. Where trenches cross roads, walks or public thoroughfares, provide suitable barricades and bridges adequately protected by signs or red flags during the day and lights at night.

5. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35°F.

L. Exact routing of trenching shall be determined by the Contractor and approved, in advance, by the General Contractor and the Architect/Engineer.

M. Every effort has been made to indicate on the drawings those existing underground services expected to interfere with or be affected by new construction.

1. It shall not be assumed that no other services exist. The Contractor shall have the responsibility to confirm all underground utilities by contacting the proper authorities before any excavation is started.

2. The Contractor shall exercise necessary precautions in process of excavation to avoid damage to unknown or unrecorded services.

3. Should such mechanical service be encountered either by the Contractor or other Contractors, it shall be the responsibility of the Contractor to determine whether such mechanical service is actively in use.

4. In the event such service is found, which had not been so noted previously, to be in use, disposition of such service shall be determined by the Architect, and an equitable adjustment to the Contract amount made.

5. In the event such service, if found to be inactive or abandoned, that part of service found to be inactive or abandoned which interferes with new work shall be removed; remaining terminals shall be plugged as required and in accordance with applicable codes under this Division of the Specifications, and as directed by the Architect.

6. Notify the Owner prior to any excavation on the site or inside the existing building.

N. Where rock and/or shale is encountered for excavation of trenches for installation of site utilities and underground building mechanical services, the rock and shale must be removed by appropriate methods to a depth of one fourth the diameter of the pipe, but not less than 4", below the bottom of the pipe; bottom of trench: refilled with sand or pea gravel to a depth required to provide proper grade or utility service and properly support pipe.

O. See Division 2 "SITE WORK", relating to excavation and sealing of pyrites-bearing shale where encountered on the project site.

P. Maintain sides and slopes of excavations in a safe condition until completion of backfilling. For deep excavations provide all required shoring and bracing.

Q. Excavate to required depth and exact slope with only sufficient dirt removed at joint locations to provide working space. Any excavations dug below the required depth shall be filled to proper depth with sand and thoroughly tamped.

R. After piping is installed, excavation shall be kept open until piping has been inspected, tested and accepted.

S. Where trenches cross roads, walks or public thoroughfares, provide suitable barricades and bridges adequately protected by signs or red flags during day and lights at night, and as directed by Architect.

3.3 BACKFILLING

A. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Inspection, testing, approval and locations of underground utilities have been recorded.

2. Removal of concrete formwork.

3. Removal of shoring and bracing and backfilling of voids.

4. Removal of trash and debris.

B. All backfilling within the building shall consist of an initial 12” layer of sand over the pipe. The remainder of the backfill shall be bank run gravel.

C. All backfilling outside the building shall be selected dirt, free of large stones, tamped on 10” layers for the first 30 inches. After initial cover, puddling will be permitted for settling of the remainder. This shall be followed by thorough tamping of the top. Trenches shall, after being refilled in accordance with the previous instructions, be mounded 6” above grade to provide for settlement. If necessary, before acceptance of work, trenches shall be filled and tamped again. Backfilling shall not be done until pipe lines are properly tested in the presence of the Architect and/or inspection of the government agency having jurisdiction.

D. Control trench soil compaction during construction for compliance with the maximum density specified in the following areas:

1. For building slabs, walkways, roadways or public thoroughfares; compact top 12” of subgrade and each layer of backfill for fill material at 95% density for cohesionless soils and 90% density for cohesive soil material. Tests to be performed by an independent testing service, with compliance report submitted to the Architect.

E. Backfill about the structures shall be placed, when practical, as the work of construction progresses. Backfilling on or against concrete work shall be done only when directed.

F. Backfilling shall progress as rapidly as the testing and acceptance of the finished sections of the work will permit and shall be carried to a crown approximately six (6) inches above the existing grades. In backfilling around duct lines, selected material shall be compacted firmly around and to a depth of not less than six (6) inches over the top of the duct. Rough grading shall be compacted thoroughly in layers and shall be brought up to within six (6) inches of finished grades. Fill and backfill shall be clean and free from vegetative matter, sticks, rocks and refuse.

G. Backfill under roadways, drives and parking areas shall be bank run gravel or approved granular material.

H. Where building service lines, such as, water, sewers, gas, fire service, etc., enter or leave building and are installed on disturbed earth, backfill, or unstable base, provide continuous support on reinforced concrete beam furnished and installed under this division. Support beam at building wall and on undisturbed earth at other end as required and/or as indicated in details on the drawings. The general Contractor is responsible for maintaining undisturbed earth portion of beam support.

I. Each Contractor shall remove from the site all excess excavated materials resulting from performance of his contract work under this division, or as directed by the Architect.

3.4 NATURAL GAS PIPE AND BACKFILLING

A. Install underground gas piping per manufacturer's recommendations in a minimum trench bed width equal to one foot wider than the nominal pipe diameter and 24" deep.

B. Place piping on a 6" bed of tamped sand with 6" sand cover.

C. In general, the material excavated from the trench may be used as backfill.

D. Final grading and seeding shall be provided under this section as specified in Division 2 of these specifications.

E. Provide yellow insulated underground copper tracer wire or other approved conductor. Provide adjacent to underground non-metallic pipe. Tracer wire shall terminate above ground at each end of the non-metallic piping. Include identification tape: yellow with black lettering "Natural Gas".

3.5 RESTORATION

A. Repave all streets or sidewalks disturbed by work performed under this division at the responsible Contractor's expense, to satisfaction of the Architect, and authorities having jurisdiction, and in accordance with details shown on "SITE WORK" drawings.

B. Full sections of concrete walks shall be removed and replaced to match.

C. Asphalt shall be trenched in straight lines, backfilled with granular fill (i.e., sand) in 6" layers, hand tamped after each layer, and patched with a minimum of 5 inches of O.D.O.T. #404 asphalt, installed in maximum 2" lifts.

1. Existing excavated asphalt and surplus sub-base shall be removed from the job site by the general Contractor.

2. Finished asphalt surface to be graded such as to avoid "ponding" of surface rain water.

D. Grassy areas shall be backfilled with best grade topsoil that is free of all rocks and debris, compacted in layers and carried to a crown of approx. 6" above existing grade. Rake to remove all stones, heavily seed (fairlawn mix) and install 3" thick cover of straw.

3.6 INSTALLATION OF IDENTIFICATION

A. Install continuous plastic underground warning tape during backfilling of trench for underground piping. Locate 6” to 8” below finished grade, directly over piping.

3.7 FIELD QUALITY CONTROL

A. Testing: Perform testing of completed piping in accordance with local authorities having jurisdiction.

3.8 CLEANING

A. Clean exposed surfaces, floors, equipment, ductwork, piping, etc., of residual debris and particulates when interior concrete patching is complete.

B. Clean exterior surfaces of all residual material once exterior pavement and sidewalk patching is complete.

C. Remove leftover patching materials and equipment from the site once patching is complete.

END OF SECTION 22 04 30

SECTION 22 04 40
EQUIPMENT PADS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

C. Division 3 "Concrete" Specifications complement the requirements of this Section.

D. Division 3 "Asphalt Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes the acceptable materials and installation methods to provide housekeeping pads, curbs, rails, inertia bases, etc., for equipment furnished under this Division.

B. Furnish all equipment, materials, labor, and supervision necessary to provide cast-in-place concrete housekeeping pads, curbs, rails, inertia bases, etc., as described herein and where indicated on the drawings. Extent of plumbing related work required by this Section is indicated on drawings and/or specified in other Division 22 Sections.

1.3 QUALITY ASSURANCE

A. Concrete Work Codes and Standards: Comply with governing regulations and, where not otherwise indicated, comply with industry standard in its application to work in each instance.

1. ACI 301 "Specifications for Structural Concrete Buildings."

2. ACI 381 "Building Code Requirements for Reinforced Concrete."

3. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice."

1.4 PROJECT CONDITIONS

A. Protect adjacent finish materials against spatter during concrete placement.

PART 2 - PRODUCTS

2.1 CONCRETE RELATED MATERIALS

A. Forms for exposed finish concrete work shall be of lumber, metal, metal-framed or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces.

1. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

2. Welded Wire Reinforcing Fabric: ASTM A 185, welded steel wire fabric.

3. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place.

2.2 CONCRETE MATERIALS

A. Materials for concrete work shall comply with requirements of Division 2 "Portland Cement Concrete Paving" Section.

B. Portland Cement: ASTM C 150, Type I.

C. Use one brand of cement throughout project, unless otherwise acceptable to Architect. Prepare design mixes for each strength of concrete indicated.

1. Fly Ash: ASTM C 618, Type C or Type F.

2. Fine Aggregate: ASTM C 33, sand.

3. Course Aggregate: ASTM C 33, crushed gravel.

2.3 DESIGN AND PROPORTIONING OF CONCRETE MIXES

A. General: Design mechanical work concrete as follows, for each 28-day compressive strength class:

1. 3000 psi Class: 500 lbs. of cement per cu. yard (5.25 sacks) and 0.46 water/cement ratio.

PART 3 - EXECUTION

3.1 INSTALLATION OF CONCRETE WORK

A. Formwork:

1. General: Design, construct, support, brace, and maintain formwork to support vertical and lateral, static and dynamic loads that might be applied until such loads can be supported by concrete structure. Construct formwork so that formed concrete will be of required size, shape, alignment, elevation, and position.

a. Construct forms to retain equipment anchor bolts in accurate locations during placement of reinforcing steel and concrete. Use templates furnished by equipment manufacturers, to locate anchor bolts, or where not furnished, locate by accurate measure from certified setting diagrams.

B. Placing Reinforcement:

1. General: Comply with requirements and recommendations of specified standards, including "Placing Reinforcing Bars" by CRSI.

C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces.

D. Chamfer exposed corners and edges using wood, metal, PVC or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

E. Provision for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support built into forms.

F. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed. Re-tightening forms and bracing after concrete placement is required to eliminate mortar leaks and maintain proper alignment. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials which would reduce bond with concrete.

G. Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.

H. Place reinforcement to obtain at least minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

I. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.

3.2 PREPARATION OF FORM SURFACES

A. Clean re-used forms of concrete matrix residue, repair and patch as required to return forms to acceptable surface condition.

B. Coat contact surfaces of forms with a form-coating compound before reinforcement is placed.

C. Thin form-coating compounds only with thinning agent of type, amount, and under conditions of form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.

D. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

3.3 REMOVAL OF FORMS

A. Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50° F for 24 hours after placing concrete, provided concrete sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.

3.4 CONCRETE PLACEMENT

A. Pre-placement inspection: Before placing concrete, inspect and complete formwork installation, reinforcement steel, and items to be embedded or cast-in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where coatings are not used.

B. General: Comply with ACI 304 "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete", and as herein specified.

C. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation.

D. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.

E. Placing Concrete Slabs: Deposit and consolidate slabs in a continuous operation within limits of construction joints, until the placing of a panel or section is completed.

F. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.

G. Bring slab surfaces to correct level with straightedge and strike-off. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.

H. Maintain reinforcing in proper position during concrete placement operations.

3.5 CONCRETE CURING AND PROTECTION

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting; keep continuously moist for not less than 7 days.

C. Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least 7 days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.

1. Cold Weather Placement: Comply with ACI 306. Do not use frozen materials or materials containing ice and snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. When air temperature has fallen or is expected to fall below 40°F, heat water and aggregates uniformly before mixing, as required to obtain concrete mixture temperature of not less than 50°F, and not more than 80°F, at time of placement. Protect concrete work from physical damage and reduced strength resulting from frost, freezing actions, or low temperatures.
2. Finishing Horizontal Surfaces: Float and trowel horizontal (top) surfaces to level, smooth, uniform textured, dense finish, where surface is to remain exposed or receive coating, membrane or other thin-set finish. Otherwise, leave struck-off surface undisturbed, except scratch surfaces which are to receive concrete or mortar topping or setting bed, by raking with a stiff broom.

3.6 MISCELLEANEOUS CONCRETE ITEMS

A. Curbs: Provide monolithic finish on interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to hard, dense finish with corners, intersections and terminations slightly rounded and coved.

B. Equipment Bases and Foundation: Provide equipment bases and foundations, as shown on drawings. Set anchor bolts for equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing equipment.

C. In the absence of more specific information, either on the drawings, or in manufacturer's literature, concrete bases shall be level, shall have a minimum height above finished floor of 4" and extend 3" beyond the skids, feet or bed plate of the item of equipment.

D. Concrete pads, pedestals, or saddles placed in existing structures shall be mounted securely to the original substrate with anchor bolts.

E. Grout base plates and foundation as indicated, using non-shrink grout. Use non-metallic grout for exposed conditions.

3.7 CONCRETE SURFACE REPAIRS

A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Architect.

B. Cut out honeycomb, rock pockets, voids over 1/4" in any dimension, and holes left by tie rods, and bolts, down to solid concrete but, in no case to a depth of less than 1 qt. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with bonding agent. Place patching mortar after bonding compound has dried.

1. Unexposed Surfaces: Repair significantly damaged and honeycombed areas, and remove major projections and fins where forms have been removed.
2. Exposed Surfaces: On formed which are to be exposed, including those to be coated or covered with membrane or other thin-set applied finish, repair and patch form-tie holes and damaged and honeycombed areas, filling voids with grout and completely removing fins and other projections.

3.8 CLEANING

A. Clean exposed surfaces, floors, equipment, ductwork, piping, etc., of residual debris and particulates when interior concrete patching is complete.

B. Clean exterior surfaces of all residual material once exterior pavement and sidewalk patching is complete.

C. Remove leftover patching materials and equipment from the site once patching is complete.

END OF SECTION 22 04 40

SECTION 22 05 10
ELECTRICAL REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

C. Separate electrical components and materials for field installation and electrical connections are specified in Division 26.

1.2 SCOPE

A. This Section specifies basic requirements for electrical components which are an integral part of plumbing equipment.

B. Specific electrical requirements for plumbing equipment are scheduled on the Drawings or described in other Sections of Division 22.

C. Provide all materials, equipment, labor and supervision necessary to install all electrical components and devices described in this Section.

D. All field wiring of components and devices described in this Section shall be by the Electrical Contractor as specified in Division 26 unless noted otherwise.

1.3 CODES AND STANDARDS

A. All electrical devices and enclosures shall comply with NEMA and IEEE Standards for the specific application in which installed.

B. Electrical components and integral wiring shall comply with the National Electrical Code (NFPA 70).

C. Electrical components and materials shall be UL labeled.

1.4 SUBMITTALS

A. For electrical components which are an integral part of packaged mechanical equipment, no separate submittal is required. Submit product data for enclosures and other electrical components with submittal data required for the equipment for which it serves, as requires by the individual equipment specifications.

B. Submit manufacturer's electrical requirements for power supply wiring. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Subject to compliance with requirements, provide motors as manufactured by one of the following:

1. A.O. Smith
2. Baldor (Reliance)
3. Emerson
4. General Electric
5. Leeson
6. Louis Allis

7. Marathon Electric
8. Teco-Westinghouse.

2.2 GENERAL

A. All plumbing equipment control panel and electrical device enclosure covers shall be provided with defeatable interlocks to permit opening of panel (by qualified personnel) while equipment is in operation.

B. Fabricate plumbing equipment for secure mounting of motors and other electrical items integral with the equipment. Provide either permanent alignment of motors with equipment or adjustable mountings as applicable for belt drives, gear drives, special couplings and similar indirect coupling of equipment. Provide safe, secure, durable, and removable guards for motor drives, arranged for lubrication and similar running-maintenance without removal of guards. Guards shall include opening for insertion of revolution counter at motor drive sheave.

2.3 MOTORS

A. For each item of equipment requiring electric drive, provide an induction motor having starting and running characteristics consistent with the torque and speed requirements of the driven equipment. In no case shall power requirements of the driven equipment exceed the nominal nameplate rating of the furnished motor (do not take advantage of service factors in selecting motors). For design, construction and performance characteristics conform to applicable provisions of latest NEMA and IEEE standards for rotating electrical equipment.

B. Unless otherwise specified, motors are to be general-purpose open-drip proof type, with Class B insulation, rated for continuous operation in 40°C ambient temperature. **All motors utilized with variable frequency drives shall be "inverter ready" motors with class F insulation in accordance with NEMA MG1 Part 31.4.4.2. All motors utilized with variable frequency drives shall be provided with a shaft ground ring in compliance with NEMA MG1 31.4.4.3.**

1. Unless otherwise scheduled on the drawings, motors 1/2 HP and smaller shall be single phase, capacitor start type, with ball bearings. Shaded-pole type with sleeve bearings are acceptable only for motors less than 1/16 HP.
2. Unless otherwise scheduled on the drawings, motors 3/4 HP and larger shall be three phase, squirrel-cage type with ball bearings.
3. Ball bearings shall be regreasable, except where motor is normally inaccessible for regular maintenance, permanently sealed ball bearings shall be provided.

C. Motors shall have a minimum efficiency as follows in accordance with IEEE Standard 112, test method B. If horsepower is not listed, motors shall have a higher efficiency than "average standard industry motors" in accordance with IEEE Standard 112, test method B.

D. Motors shall be furnished with stainless steel nameplate indicating manufacturer, ratings, characteristics, construction, efficiency and special features.

2.4 MANUAL MOTOR STARTERS

A. In general, single phase motors shall be equipped with manual motor starters. Manual motor starters shall be provided and installed by the electrical contractor as specified in Division 26 unless noted otherwise on the Division 22 drawings or in the Division 22 specifications.

B. Enclosures in dry indoor locations shall be general purpose NEMA Type 1, unless noted otherwise. Enclosures in wet indoor or outdoor locations shall be NEMA Type 4 (stainless steel, unless noted otherwise).

C. Manual motor starter shall include neon pilot light, "Quick-make, quick-break" trip-free toggle mechanism and melting alloy thermal overload relay sized to protect the motor.

2.5 COMBINATION MOTOR STARTERS

A. In general, three phase motors shall be equipped with combination motor starters. Combination motor starters shall be provided and installed by the electrical contractor as specified in Division 26 unless noted otherwise on the Division 22 drawings or in the Division 22 specifications.

B. Enclosures in dry indoor locations shall be general purpose NEMA Type 1, unless noted otherwise. Enclosures in wet indoor or outdoor locations shall be NEMA Type 4 (stainless steel, unless noted otherwise).

C. Size of starters shall be as recommended by the motor or driven equipment manufacturer.

D. Combination motor starters shall include a disconnect as specified in the following section "2.5 Disconnect Switches". Starter shall be furnished with the following devices:

1. "HAND-OFF-AUTO" selector switch in cover.

2. Heavy duty push-to-test red pilot light to illuminate when motor is running.

3. Control power transformer (coordinate secondary voltage with required control voltage). Control transformer primary shall be connected to the load side of the incoming line disconnect fuses and the secondary shall be fused and grounded.

4. Three (3) bi-metal type thermal overload elements. The starter shall be inoperative if any thermal element is removed.

5. Minimum of two NO/NC field convertible auxiliary contacts. Two NO and two NC contacts may be furnished in lieu of convertible contacts.

6. Engraved nameplate on the door describing the equipment controlled.

2.6 DISCONNECT SWITCHES

A. Disconnect switches shall be provided and installed by the electrical contractor as specified in Division 26 unless noted otherwise on the Division 22 drawings or in the Division 22 specifications.

B. In dry indoor locations, enclosures shall be general purpose NEMA Type 1, unless noted otherwise. In wet indoor or outdoor locations enclosures shall be NEMA Type 4 (stainless steel), unless noted otherwise.

C. Size of disconnect switches shall be as recommended by the motor or driven equipment manufacturer.

D. Disconnect switches shall be fusible type, with Class R rejection fuse clips.

1. The disconnect handle shall always be in control of the disconnect device with the door open or closed. The disconnect handle shall be clearly marked as to whether the disconnect device is "ON" or "OFF", and shall include a two-color handle grip, the black side visible in the "OFF" position indicating a safe condition, and the red side visible in the "ON" position indicating a dangerous condition.

2. Disconnect handle shall contain provisions for padlocking in the "OFF" position.

3. If required, the disconnect switch shall be furnished with one auxiliary SPDT contact for use by the Controls Contractor to de-energize remotely powered interlock wiring when the disconnect is in the "OFF" position.

E. Disconnect switches shall be furnished with a ground lug.

PART 3 - EXECUTION

3.1 GENERAL INFORMATION

A. Install motors on motor mounting systems in accordance with motor manufacturer's instructions, securely anchored to resist torque, drive thrusts, and other external forces inherent in mechanical work. Secure sheaves and other drive units to motor shafts with keys and Allen set screws, except motors of 1/3 HP and less may be secured with Allen set screws on flat surface of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.

B. Install starters and wiring devices at location indicated, securely supported and anchored, and in accordance with manufacturer's installation instructions. Locate for proper operational access, including visibility, and for safety.

C. Install power and control connections for motors to comply with NEC and applicable provision of Division 26 sections. Install grounding except where non-grounded isolation of motor is indicated.

D. Prior to the purchase or installation of any equipment, verify all motor voltage characteristics with the Electrical Contractor.

E. Make final electrical connection to all motors with flexible metal conduit unless plug-in electrical cords are specified. Line voltage terminations shall be by the Electrical Contractor.

END OF SECTION 22 05 10

SECTION 22 05 20
VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies variable frequency drives (VFD's) utilized to control the speed of specific motor driven mechanical equipment and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

C. Specific electrical requirements (i.e., horsepower and electrical characteristics) for mechanical equipment are specified herein and scheduled on the drawings.

D. All variable frequency drives that are not an integral part of packaged equipment, shall be furnished by the Contractor designated on the drawings and installed/set/wired by the Electrical Contractor unless otherwise noted as furnished by others.

1.3 CODES AND STANDARDS

A. All variable frequency drives, including installation, shall comply with the requirements of the National Electric Code and the local authorities having jurisdiction.

B. UL Compliance: Provide VFD's that are UL listed and approved.

C. NEMA Standards ICS 7.1 – 2006: Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems.

D. NEMA Standards MG 1: Motors and Generators.

E. NEMA Standards ICS 2: Industrial Control Devices, Controllers and Assemblies.

F. NEMA Standard 250: Enclosures for Electrical Equipment.

G. NEMA Standard KS 1: Enclosed Switched.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of VFD's, of types and capacities required, whose products have been in satisfactory use in similar service for not less than three (3) years.

B. To ensure quality and minimize infantile failures at the jobsite, the complete VFD shall be tested by the manufacturer. The VFD shall operate a dynamometer at full load and the load and speed shall be cycled during the test.

C. All optional features shall be functionally tested at the factory for proper operation.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's specifications, installation and start-up instructions and all accessories clearly indicated. Submit manufacturer's performance data including dimensional drawings, power circuit diagrams, installation and maintenance manuals, warranty description, VFD's FLA rating, certification agency file numbers and catalog information.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, required clearances and methods of assembly of components.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to VFD's. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

D. Maintenance Data: Submit maintenance data and parts lists for each type of VFD control and accessory, including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings and wiring diagrams in maintenance manual, in accordance with requirements of Division 1.

E. The specification lists the minimum VFD performance requirements for this project. Each supplier shall list any exceptions to the specification. If no departures from the specification are identified, the supplier shall be bound by the specification.

F. Submittal data for variable frequency drives that are factory-installed as an integral part of packaged mechanical equipment shall be included with the packaged mechanical equipment submittal. No separate submittal is required.

G. Start-up Report: Provide completed start-up form, per the requirements of Section 23 03 20.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Handle VFD's and components in clean dry place. Product from weather, dirt, fumes, water, constructive debris and physical damage. Retain shipping protective covers and protective enclosures during storage.

B. Store VFD's and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage. Retain shipping protective covers and protective enclosures during storage.

C. Each VFD shall be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD's shall not be operated while covered.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide variable frequency drives as manufactured by one of the following:

1. ABB Inc.
2. Cutler-Hammer
3. Dan Foss Graham
4. Square D
5. Yaskawa

2.2 GENERAL

A. Furnish complete variable frequency drives as specified herein for the pumps designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. In dry indoor locations, VFD shall be housed in a metal NEMA 1 enclosure. In wet indoor or outdoor locations, VFD shall be housed in a stainless steel NEMA 3R ventilated enclosure.

B. The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control and to negate the need for motor derating.

C. An advanced sine wave approximation and voltage vector control shall be used to allow operation at rated motor shaft output at nominal speed with no derating. This voltage vector control shall minimize harmonics to the motor to increase motor efficiency and life.

D. The VFD shall include a full-wave diode bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.

E. The VFD and options shall be tested to ANSI/UL Standard 508. The complete VFD, including all specified options, shall be assembled by the manufacturer, which shall be UL-508 certified for the building and assembly of option panels. Local representative panel shop assembly for option panels is not acceptable. The appropriate UL stickers shall be applied to both the drive and option panel, in the case where these are not contained in one panel.

F. The VFD shall have a DC line reactor to minimize power line harmonics. VFDs without a DC line reactor shall provide a 3% impedance AC line reactor.

G. The VFD's full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting.

H. The VFD shall be able to provide full torque at any selected speed up to base speed to allow driving direct drive fans without derating.

I. An automatic energy optimization selection feature shall be provided standard in the drive. This feature shall automatically and continually monitor the motor's speed and load and adjust the applied voltage to maximize energy savings and provide a 3% to 10% additional energy savings.

J. Input and output power circuit switching can be done without interlocks or damage to the VFD.

K. An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or decouple the motor from the load to run the test.

L. Electromagnetic interference (EMI) and radio frequency interferences (RFI) filtering is required for installations that separate the VFD from the motor by more than 150 feet. Specific filters must be provided by the manufacturer to eliminate noise and transmission losses.

2.3 PROTECTIVE FEATURES

A. Class 20 I^2t electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor applications.

B. Protection against input transients, loss of AC line phase, short circuit, ground fault, overvoltage, undervoltage, drive overtemperature and motor overtemperature. The VFD shall display all faults in plain English. Codes are not acceptable.

C. Protect VFD from sustained power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output with an input voltage as low as 150 volts for 208/230 volt units, and 285 volts for 460 volt units.

D. The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.

E. Drive shall have semi-conductor rated input fuses to protect power components.

F. To prevent breakdown of the motor winding insulation, the dV/dt must be below 1500 V/msec per IEC recommendations. The supplier shall include with the quotation the dV/dt values of the drive.

G. Drive shall include a "signal loss detection" circuit to sense the loss of the control signal, and shall be programmable to react as desired in such instance.

H. Drive shall be designed and constructed so that input or outputs can be disconnected with the drive running without the need for interlocks.

I. Drive shall catch a rotating motor operating forward or reverse up to full speed.

J. VFD shall be rated for 100,000 amp interrupting capacity (AIC).

K. Drive shall include current sensors on all three output phases to detect and report phase loss to the motor. The VFD will identify which of the output phases is low or lost.

L. Drive shall continue to operate without faulting until input voltage exceeds 300 volts on 208/230 volt drives, and 604 volts on 460 volt drives.

2.4 INTERFACE FEATURES

A. Hand/Start, Off/Stop and Auto/Start selector switches shall be provided to start and stop the drive and determine the speed reference.

B. Provide a 24 V DC output signal to indicate that the drive is in Auto/Remote mode.

C. Digital manual speed control. Potentiometers are not acceptable.

D. Lockable, alphanumeric backlit display keypad can be remotely mounted up to 10 feet away using standard 9-pin cable. All keypads shall be identical and interchangeable. Drive may be operated with keypad removed. All drives shall use the same control keypad.

E. To setup multiple drives, it shall be possible to upload all setup parameters to the drive's keypad, place that keypad on all other drives in turn and download the setup to each drive.

F. The display shall have four lines, with 20 characters on three lines and eight large characters on one line.

G. Two lines of the display shall allow free programming so that the exact unit controlled by the drive can be identified.

H. A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the drive when the keypad is removed.

I. A quick setup menu with factory preset typical HVAC parameters shall be provided on the drive eliminating the need for macros.

J. Two set-point control interface (PID control) shall be standard in the unit. Drive shall be able to look at two feedback signals, compare with two set-points and make various process control decisions.

K. Floating point control interface shall be provided to increase/decrease speed in response to switch closures.

L. Sleep mode shall be provided to automatically stop the drive when speed drops below set "sleep" level for a specified time. Drive automatically restarts when speed command exceeds set "wake" level.

M. Run permissive circuit shall be provided to accept a "system ready" signal to assure that the drive does not start until dampers or other auxiliary equipment are in the proper state for drive operation.

N. An elapsed time meter and kWh meter shall be provided.

O. The following displays shall be accessible from the control panel in actual units: Reference Signal Value in actual units, Output Frequency in Hz or percent, Output Amps, Motor HP, Motor kW, kWhr, Output Voltage, No Load Warning, DC Bus Voltage, Drive Temperature in degrees, and Motor Speed in engineering units per application (in percent speed, GPM, CFM,...). Drive will read out the selected engineering unit either in a linear, square or cubed relationship to output frequency as appropriate to the unit chosen.

P. Up to four meter displays can be shown at once on the display. This allows the actual value of the follower signal to be shown simultaneously with the drive's response to that signal for ease in commissioning.

Q. Drive will sense the loss of load and signal a no load/broken belt warning or fault.

R. The VFD shall have temperature controlled cooling fans for quiet operation and minimized losses.

S. The VFD shall store in memory the last 20 faults and record all operational data.

T. Eight programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.

U. Two programmable relay outputs, one Form C 240 V AC, one Form A 50 V AC, shall be provided for remote indication of drive status.

V. Three programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include two voltage (0-10 V dc, 2 to 10 V dc) and one current (0 to 20 mA, 4 to 20mA) input.

W. Two programmable 0-20 mA analog outputs shall be provided for indication of drive status. These outputs shall be programmable for output speed, voltage, frequency, amps and input kW.

X. Under fire mode conditions the VFD shall automatically default to a preset speed.

2.5 ADJUSTMENTS

A. VFD shall have an adjustable carrier frequency.

B. Sixteen preset speeds shall be provided.

C. Four acceleration and four deceleration ramps shall be provided. Accel and decel time shall be adjustable over the range from 0 to 3,600 seconds to base speed. The shape of these curves may be automatically contoured to prevent tripping.

D. Four current limit settings shall be provided.

E. If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: undervoltage, overvoltage, current limit, inverter overload and motor overload.

F. The number of restart attempts shall be selectable from 0 through 20 and the time between attempts shall be adjustable from 0 through 600 seconds.

G. An automatic "on delay" may be selected from 0 to 120 seconds.

2.6 AUTOMATION SYSTEM INTERFACE

A. The VFD's shall communicate directly with the Building Automation System through the local area network.

B. The VFD's shall communicate directly with the building automation system. This connection to the system shall allow all operating parameters, speed control, drive configuration, and status of the drives to be both read and changed through the bus connection. Modulating signal, enable/disable, remote disconnect status and general alarm signals shall be hard wired.

2.7 BYPASS

A. Where indicated, provide a manual bypass consisting of a door interlocked main fused disconnect padlockable in the off position, a built-in motor starter and a three position HAND/OFF/AUTO switch controlling three contactors. In the DRIVE position, the motor is operated at an adjustable speed from the drive. In the OFF position, the motor and drive are disconnected. In the HAND position, the motor is operated at full speed from the AC power line and power is disconnected from the drive so that service can be performed. A Customer supplied normally closed dry contact shall be interlocked with the drives safety trip circuitry to stop the motor whether in AUTO or HAND mode in case of an external safety fault.

2.8 DISCONNECT

A. Provide a door interlocked, padlockable circuit breaker that will disconnect all input power from the drive and all internally mounted options.

2.9 SERVICE CONDITIONS

A. Ambient temperature, -10 to 40°C (14 to 104°F).

B. 0 to 95% relative humidity, non-condensing.

C. Elevation to 3,300 feet without derating.

D. AC line voltage variation, -10 to +10% of nominal with full output.

E. No side clearance shall be required for cooling of any NEMA 1 units, or of any NEMA 12 units of less

PART 3 - EXECUTION

3.1 EXAMINATION

A. Contractor to verify that job site conditions for installation meet factory recommended and code-required conditions for VFD installation prior to start-up, including clearance spacing, temperature, contamination, dust, and moisture of the environment. Separate conduit installation of the motor wiring, power wiring, and control wiring, and installation per the manufacturer's recommendations shall be verified.

B. The VFD is to be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD shall not be operated while the unit is covered.

3.2 INSTALLATION

A. All variable frequency drives shall be furnished by the designated Contractor and installed/set/wired by the Electrical Contractor unless otherwise noted as furnished by others.

3.3 WARRANTY

A. The VFD shall be warranted by the manufacturer for a period of 36 months from date of shipment. The warranty shall include parts, labor, travel costs and living expenses incurred by the manufacturer to provide factory authorized on-site service. The warranty shall be provided by the VFD manufacturer.

3.4 START-UP SERVICE

A. The manufacturer shall provide start-up commissioning of the variable frequency drive and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. The commissioning personnel shall be the same personnel that will provide the factory service and warranty repairs at the customer's site. Sales personnel and other agents who are not factory certified technicians for VFD field repair shall not be acceptable as commissioning agents. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system. Start-up shall include customer operator training at the time of the equipment commissioning.

3.5 DEMONSTRATION AND TRAINING

A. Owner's Instructions: Provide services of a manufacturer's technical representative for two (2) separate 4-hour days to instruct Owner's personnel in operation and maintenance of variable frequency drives.

1. Schedule training with Owner, provide at least 7-day notice to Contractor and Engineer of training date.

END OF SECTION 22 05 20

SECTION 22 07 10
PENETRATIONS AND SLEEVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section specifies basic requirements for walls, roof and floor penetrations.

B. Furnish all equipment, materials, labor, and supervision necessary to make all required mechanical penetrations as described herein.

1.3 CODES AND STANDARDS

A. Underwriters' Laboratory (UL)

B. ASTM E-84 (NFPA 255)

1.4 SUBMITTALS

A. Slab-on-grade floors and below-grade wall penetration seal: Submit manufacturer's cutsheet(s), including dimensions, materials, installation recommendations, ratings and code compliance information, etc.

B. Shop Drawings: Provide, per requirements of Section 22 01 20.

PART 2 - PRODUCTS

2.1 BELOW-GRADE WALL AND SLAB-ON-GRADE FLOOR PENETRATION SEALS

A. Mechanical seals shall consist of intumescent synthetic rubber plugs, plastic or stainless steel pressure plates, and stainless steel bolts.

B. Subject to compliance with requirements, provide below-grade wall and floor slab penetration seals as manufactured by one of the following:

1. Metra-Flex
2. Thunderline Corp

2.2 PIPE SLEEVE MATERIALS

A. Schedule 40 black steel pipe.

2.3 SOUND STOPPING

A. Fiberglass insulation, 2 lb density.

B. Material shall be non-asbestos and non-friable.

C. Provide all insulation materials with a flame-spread index of 25 or less and smoke developed index of 50 or less, as tested under procedure ASTM E-84 (NFPA 255).

2.4 ESCUTCHEONS

A. Escutcheons shall be chrome plated brass.

PART 3 - EXECUTION

3.1 GENERAL

A. Pipe sleeves are required at all pipes penetrating concrete walls, masonry walls, fire walls and smoke barrier walls.

B. Where concrete or masonry walls are core drilled for pipe passage, steel sleeves are not required.

C. Where concrete floor slabs or concrete roof slabs are core drilled for pipe passage, steel sleeves are not required – except in mechanical rooms and all rooms containing water piping.

D. In new concrete walls, floors, and roofs, coordinate the exact locations of pipe sleeves with the General Trades Contractor performing the work prior to concrete pour.

E. Each Contractor is responsible to furnish and install his own pipe sleeves.

3.2 CUTTING AND PATCHING

A. This Contractor shall provide all penetrations in new and existing construction required for the installation of fixtures, plumbing piping, conduit, and equipment. Do not cut any structural member without specific permission from the Architect.

B. Penetrations shall be cut as small as practical with as little damage as possible and in a manner satisfactory to the Architect.

C. This Contractor shall patch all penetrations and repair all damage caused by the installation and/or removal of plumbing systems. All materials shall be new and shall match the adjacent construction.

D. Finishing (paint, wall covering, etc.) shall not be included under this Section.

E. The General Trades Contractor shall flash all plumbing vents into roofing system.

3.3 MASONRY OR CONCRETE WALL BELOW-GRADE AND FLOOR SLABS ON-GRADE:

A. Sleeves shall be one inch (1") larger than the outside diameter of the pipe including insulation where applicable, or two pipe sizes larger, whichever is bigger.

B. Set pipe wall sleeves with ends of sleeves flush with wall faces. Set pipe floor sleeves with top of sleeve 4 inches above finished floor in water entry rooms, Mechanical rooms, and wet floor locations.

C. Center pipes in sleeves.

D. Provide below-grade mechanical wall and floor penetration seals to fill the annular space between the pipe and floor slab or outside wall and sleeve. Center penetration seal within the opening. Comply with penetration seal manufacturer's installation instructions.

3.4 MASONRY OR CONCRETE WALL ABOVE-GRADE

A. Sleeves shall be one inch (1") larger than the outside diameter of the pipe including insulation where applicable, or two pipe sizes larger, whichever is bigger.

B. Set pipe sleeves with ends of sleeves flush with wall faces.

C. Center pipes in sleeves.

D. For fire or smoke rated walls, fill the annular space between the pipe and the sleeve with the proper firestopping material. See "Firestopping" specification section, this Division for products and installation methods.

E. For unrated walls, fill the annular space between the pipe and the sleeve with sound stopping.

3.5 CONCRETE FLOOR OR ROOF:

A. Sleeves shall be 1 inch larger than the outside diameter of the pipe, or two pipe sizes larger, whichever is bigger.

B. Set pipe sleeves with top of sleeve flush with roof slab or deck surface.

C. Set pipe sleeves with top of sleeve to be 4 inches above finished floor in water entry rooms, Mechanical rooms and wet floor locations.

D. Center pipes in sleeves.

E. For fire or smoke rated floors and roofs, fill the annular space between the pipe and the sleeve with the proper firestopping material. See "Firestopping" specification section, this Division for products and installation methods.

F. For unrated floors and roofs, fill the annular space between the pipe and the sleeve with sound stopping. Note – roof penetrations shall be made via roof curbs.

3.6 SOUND STOPPING

A. Where pipes or other components of Division 22 work pass through non-fire rated walls, provide sound stopping between such work and the wall material intended to reduce the transmission of sound from on side of the wall to the other.

B. Sound stopping of pipes in sleeves shall consist of sealing the outside of the sleeve with caulking and the inside with an insulating material.

C. Sound stopping of pipes without sleeves shall consist of packing the cavity around the penetration with an insulating material and sealing the opening with approved sealant or plaster.

D. Insulating materials shall be non-asbestos and non-friable, and shall have a flame spread rating of no more than 25 and a smoke developed rating of no more than 50.

3.7 ESCUTCHEONS

A. Fit all pipe passing exposed through walls, floors, or ceilings in finished rooms with chrome-plated brass escutcheons. Where adjacent surface is to receive a paint finish, prime paint escutcheons, otherwise escutcheons shall be chrome plated. Provide escutcheons on all plumbing piping wall penetrations within counters.

END OF SECTION 22 07 10

SECTION 22 07 20
FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section specifies firestopping materials and installation requirements for the penetration of rated assemblies. Portions of this Section may not be required in this project. Actual field conditions, penetration type (pipe, etc.) and assembly type, shall define exact firestopping requirements.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in the Section.

1.3 QUALITY ASSURANCE

A. The firestop system installation shall be UL Listed and tested in accordance with ASTM E814.

B. Fire rating of the firestop system shall be equivalent to the assembly which is penetrated.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products as manufactured by one of the following:

1. Hilti, Inc.
2. 3M; Fire Protection Products Division.
3. Thermafiber Safing
4. Specified Technologies Inc.
5. FireTrak Corp.

2.2 MATERIALS

A. All products used under this Section shall be UL listed for the purpose.

1. Piping, ductwork, and sleeve penetrations of rated assemblies shall be sealed with the appropriate intumescent caulk, putty, strip, block, or sheet type fire barrier product

B. Fire barrier products shall be installed in accordance with all U.L. System requirements for the type of penetration and firestopping system used. The following U.L. System descriptions are those of Hilti Inc. firestopping systems.

Table 22 07 20.1

Penetration (F rating)	UL System
Metal pipe through gypsum board (1 or 2 hour)	Hilti UL #WL1054 or approved equal
Metal pipe through masonry/concrete (2 hour)	Hilti UL #CAJ1291 or approved equal
Metal pipe through poured concrete floor slab (3 hour)	Hilti UL #FA1017 or approved equal

Penetration (F rating)	UL System
Insulated metal pipe through gypsum board (1 or 2 hour)	Hilti UL #WL5029 or approved equal
Insulated metal pipe through masonry/concrete (2 hour)	Hilti UL #CAJ5091 or approved equal
Insulated metal pipe through poured concrete floor slab (2 hour)	Hilti UL #FA5017 or approved equal
Plastic pipe through gypsum board (1 or 2 hour)	Hilti UL #WL2078 or approved equal
Plastic pipe through masonry/concrete (2 hour)	Hilti UL #CAJ2271 or approved equal
Plastic pipe through poured concrete floor slab (3 hour)	Hilti UL: #FA2054 or approved equal

1. Actual project conditions may require a UL System not specifically described above. Fire barrier products manufacturer shall provide a UL System to meet actual project conditions.

PART 3 - EXECUTION

3.1 GENERAL

A. All penetrations (pipe, etc.) through fire rated assemblies shall be firestopped.

B. All firestopping materials shall be installed per the manufacturer's instructions.

C. Examine the areas and conditions where firestops are to be installed and notify the Architect of conditions detrimental to the proper and timely completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected by the contractor in a manner acceptable to the Architect.

D. Unused sleeves or core drilled holes shall be plugged with fire resistant material and finished to match adjacent surfaces.

E. Finish surfaces of firestopping, which is to remain exposed to view, to a uniform and level condition.

F. Field Quality Control:

1. All areas of work must be accessible until notification and inspection by the applicable Code authorities.

2. Have firestops examined by proper authorities to ensure proper installation and full compliance with this specification. If required, show proof of compliance by providing the appropriate UL firestopping system number.

3. Correct unacceptable firestops and provide additional inspection to verify compliance with this specification at no additional cost.

G. If requested, the Contractor shall show proof of compliance by providing the appropriate UL firestopping system number to the inspection Authority Having Jurisdiction or the Architect.

END OF SECTION 22 07 20

SECTION 22 07 30
ROOF CURBS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies roof curbs and rails utilized to support and elevate equipment above roofs. To insure compatibility, roof curbs, rails and supports should be furnished by the rooftop equipment manufacturer, wherever possible, in compliance with this Section.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver roof curbs and support rails in factory-fabricated crates, containers or wrapping which properly protect roof curbs and support rails from damage.

B. Store roof curbs and support rails in original packaging and protect from weather and construction traffic. Whenever possible, store indoors. Where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle roof curbs and support rails carefully to prevent damage, breaking, denting and scoring of finishes. Do not install damaged units or components; replace with new.

1.5 SEQUENCING AND SCHEDULING

A. Coordinate the installation of roof curbs, equipment supports and roof penetrations with the General Contractor.

B. Coordinate the size and location of structural steel support members.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide prefabricated roof curbs manufactured by one of the following:

1. Custom Curb, Inc.
2. Pate Co.
3. Roof Products & Systems Corp.
4. ThyCurb Div.; Thybar Corp.
5. Associated Rooftop Equipment Manufacturer

2.2 ROOF ACCESSORIES

A. Roof flashings for HVAC equipment are specified elsewhere in this Division of the Specifications.

2.3 ROOF EQUIPMENT, PIPING AND DUCT SUPPORTS

A. Fabricate roof curbs and roof support curbs from zinc-coated steel, ASTM A 146, Grade C, designation G90 hot-dip coating, mill phosphatized. Clean and paint with rust-inhibitive metal primer paint of type recommended by manufacturer, 2.0 mils dry film thickness.

B. Reinforce continuous runs of over 3'-0" length, by inserting welded stiffeners of heavy gauge with flanges as required to provide sufficient rigidity and strength to withstand maximum lateral forces in addition to superimposed vertical loads.

C. Fabricate curbs of minimum 18 gauge galvanized metal and to a minimum height above roof surface of 12 in.

D. Provide pressure treated wood nailer, not less than 1-5/8 in. thick and of width indicated, but not less than width of support wall assembly. Anchor nailer securely to top of metal frame unit. Wood shall be pressure treated with water-borne preservatives for "above ground" use, complying with AWPB LP-2.

E. Insulate curb's inside structural support wall with rigid glass fiber insulating board of approximately 3 lb. density and 1-1/2 in. minimum thickness, except as otherwise indicated.

2.4 PIPING PENETRATION ROOF CURBS

A. All roof piping curbs shall be sealed watertight utilizing an ABS thermoplastic KORAD acrylic cover. Cover shall contain molded, graded boots of quantity and sizes to accommodate roof piping penetrations controls conduit and electrical conduit as indicated. Provide two (2) stainless steel pipe clamps per boot. Covers shall be as manufactured by the same manufacturer as roof curbs.

2.5 NON-INVASIVE SUPPORTS

A. Acceptable Manufacturers: Furnish non-invasive supports as manufactured by one of the following acceptable manufacturers:

1. Miro
2. Erico
3. Cooper B-Line
4. Mifab
5. Rooftop Support Systems

B. Non-invasive pipe supports shall support piping above the roof with support not incorporated into the roofing system. Base shall be composed of crumb rubber with urethane binding agent compression molded on a hydraulic press. Fixing hardware shall be hot dip galvanized steel. “Roller Bearing” pipe supports shall be provided where indicated above.

PART 3 - EXECUTION

3.1 ROOFING WORK

A. Coordination

1. Coordinate the type of roofing materials and approved penetration methods with the General Contractor prior to making penetrations. Provide components and installation as specified below or as directed by the General Contractor.

2. The Mechanical Contractor shall locate all roof mounted equipment and roof penetrations. The General Contractor shall provide all roof openings and shall perform all roofing work required to incorporate roof curbs into roofing system.

B. Roof Curbs and Roof Equipment Supports

1. Where supports or curbs are not specified with mechanical equipment; provide prefabricated equipment supports or curbs for roof mounted equipment.

2. Where pipes penetrate the roof provide prefabricated pipe curb assemblies or pipe seals.

3. Coordinate requirements with the electrical contractor and controls contractor and provide openings in curbs to accommodate electrical and controls conduits.

END OF SECTION 22 07 30

SECTION 22 07 40
MISCELLANEOUS STEEL SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes the materials, fabrication, and installation requirements miscellaneous steel supports, structures, and reinforcements required for the proper installation of plumbing systems and equipment.

B. Furnish all material, equipment, labor, and supervision necessary to provide steel supports, structures, and reinforcements as required by this division of the specifications.

1.3 CODES AND STANDARDS

A. Design all miscellaneous steel in accordance with AISC Steel Handbook .

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Furnish and install all miscellaneous steel for supports, structures, hangers, anchors, guides, etc., required for installation of equipment and material furnished and installed under this division.

B. General: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, with edges and surfaces level, plumb, and true.

1. Fit exposed connections accurately together. Weld connections that are not to be left as exposed joints but cannot be shop welded. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication.

2. Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction.

3. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

C. Set bearing and leveling plates on cleaned surfaces using wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts and pack solidly with nonshrink, nonmetallic grout.

D. Touch up surfaces and finishes after erection.

1. Painted Surfaces: Clean field welds, bolted connections, and abraded areas and touch up paint with the same material as used for shop painting.

2. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 22 07 40

SECTION 22 08 10
VIBRATION ISOLATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies vibration isolation products and includes general description and installation methods.

B. Vibration isolation products furnished as an integral part of factory fabricated equipment are specified as part of the equipment in other sections of Division 22.

C. Provide all materials, equipment, labor and supervision necessary to install and perform all vibration isolation work described in this Section.

1.3 QUALITY ASSURANCE

A. Except as otherwise indicated; obtain vibration isolation products from a single manufacturer.

B. Engage manufacturer to provide proper selection and technical supervision of installation of vibration control products.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide isolators as manufactured by one of the following:

1. Amber Booth
2. Consolidated Kinetics Corp.
3. Flex-Hose Co.
4. Keflex
5. Korfund Dynamics Corp.
6. Mason Industries, Inc.
7. Metraflex
8. Peabody
9. Twin City Hose, Inc.
10. Vibration Eliminator Co.

2.2 GENERAL

A. Furnish and install vibration isolating mountings to isolate from the structure, by means of resilient vibration and noise isolators, all equipment having rotating or reciprocating parts. Isolators shall be supplied by a single source, and shall be guaranteed by the manufacturer to provide isolation efficiencies in accordance with this specification. Selection shall be based on equipment proposed, power dissipated, frequency, weight distribution and nature of the building structure.

B. Selection of the mountings shall be made of the manufacturer to provide a transmissibility not exceeding 10%.

C. Vibration of noise created in any part of the building by the operation of any equipment furnished and/or installed under this Contract shall be prohibited, and this Contractor shall take all precautions by isolating the various items of equipment, pipe and sheet metal work from the building structure. The major items of equipment shall be isolated as called for on the plans and specified herein. The minor items shall be held the responsibility of this Contractor.

D. Vibration isolators shall have either known undeflected heights or their markings so, after adjustment, when carrying their full load, the deflection under load can be verified, this determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided.

E. Size vibration isolators to operate in the linear portion of their load versus deflection curve. Furnish load versus deflection curves (linear over a deflection range 50 percent above the design deflection).

F. The ratio of lateral to vertical stiffness of vibration isolators shall not be less than 1.0 or greater than 2.0.

G. The vertical natural frequency for each support point based upon the load per isolator and isolator stiffness shall not differ by more than plus or minus 10 percent.

H. Shore hardness of neoprene mountings: 40 to 60 after minimum aging of 20 days or corresponding overaging.

I. Design or treat all isolators for resistance to corrosion. Structural steel bases shall be cleaned of welding slag and painted with a coat of red lead primer for interior use, and hot dip galvanized after fabrication for exterior use. All nuts, bolts and washers shall be zinc electroplated for interior use and hot dip galvanized for exterior use.

J. Select all mounts to perform their function without undue stress or overloading. All isolators that are to be used with structural steel bases shall be equipped with height saving brackets. The bottom of the brackets shall be 1-1/2 inches above the floor. Furnish isolators with a method of leveling and where spring isolators are used, provide gussets on both sides of the isolators or other structural reinforcement as required to prevent distortion.

K. Construct all structural steel bases with a minimum of four points of support. Structural steel bases: coped and fitted or constructed using the overlap insert method. Operating clearance of steel bases: at least 1-1/2 inches above the floor or housekeeping pad, clearance not to exceed 2-1/2 inches.

2.3 EQUIPMENT ISOLATION

A. Isolate in-line pump support rods from building structure with rubber grommet type isolators. Install braided hose flexible connectors on inlet and discharge side of in-line pumps. Braided flexible hose connectors shall be constructed of stainless steel hose covered with stainless steel wire braid with NPT steel nipples or 150 psig ANSI flanges, welded to hose. Connectors shall be as manufactured by Flex-Hose Co., Metraflex or Twin City Hose.

B. Isolate each base mounted pump and compressor from the piping systems by use of pipe-size neoprene or EDPM ("rubber") type flexible connector couplings constructed of multiple piles of nylon and bias-ply tire cord reinforcing fabric with Control Cable and 150 psig ANSI steel flanges.

C. Install braided hose flexible connectors on discharge side of air compressors. Braided flexible hose connectors shall be constructed of stainless steel hose covered with stainless steel wire braid with NPT steel nipples or 150 psig ANSI flanges, welded to hose. Connectors shall be as manufactured by Flex-Hose Co., Metraflex or Twin City Hose, Inc.

D. All floor supported piping and pipe hangers in the Equipment rooms shall be mounted on steel spring vibration isolators in combination with precompressed molded fiberglass noise isolators, designed for minimum static deflections of 1".

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which vibration control units are to be installed. Do not proceed with work until satisfactory conditions have been corrected in manner acceptable to installer.

3.2 PERFORMANCE OF ISOLATORS

A. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's recommendations for selection and application of vibration isolation materials and units.

3.3 INSTALLATION

A. General: except as otherwise indicated, comply with manufacturer's instructions for installation and load application to vibration control materials and units. Adjust to ensure that units have equal deflection, no not bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices intended for temporary support during installation.

B. Adjust leveling devices as required to distributed loading uniformly onto isolators. Shim units as required where substrate in not level.

END OF SECTION 22 08 10

SECTION 22 10 10
COMMON PIPING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Specifications of this Division complement the requirements of this Section.

C. For general Codes and Standards requirements refer to Section 22 00 20.

D. See other Division 22 Sections for medical gas system piping requirements.

E. See other Division 22 Sections for high purity water system piping requirements.

F. See other Division 22 Sections for acid waster and vent system piping requirements.

1.2 SCOPE

A. This Section specifies piping materials and installation methods common to more than one section of Division 22 and includes fittings, joining methods, and basic piping installation instructions.

B. Not all pipe materials and joining methods listed in this section pertain to this project. See specific system specification sections within this Division for approved materials and installation methods allowed to be used on this project.

C. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. Compliance: Furnish and install plumbing system piping in accordance with regulations required by local the local authority having jurisdiction.

B. Water Department/Local Authority Compliance: Furnish and install plumbing system piping in accordance with regulations required by local Water Department, and local authority having jurisdiction.

C. All plumbing piping systems shall be installed in accordance with the applicable Plumbing Code.

D. Domestic water piping for service line, meter setting and up to building reducing pressure backflow preventer shall be of materials approved by the Water Department having jurisdiction. See also Section 22 10 31.

E. Comply with ANSI/NSF Standard 61 Drinking Water System Components – Health Effects.

F. All natural gas systems shall be installed in accordance with the Local Mechanical Code and all requirements of the local authorities having jurisdiction.

G. All natural gas systems shall comply with the latest "International Fuel Gas Code", and local utility requirements.

H. ASHRAE: Comply with the ASHRAE Equipment Handbook, Chapter 6, for Chimney, Gas Vent, and Fireplace Systems, material requirements and design criteria.

I. National Fuel Gas Code: Comply with National Fuel Gas code for gas pipe installation.

1.4 DEFINITIONS

A. DWV: Drain, Waste and Vent

B. EPDM: Ethylene Propylene Diene Monomer

C. NPS: Nominal pipe size

PART 2 - PRODUCTS

2.1 GENERAL

A. Piping Materials:

1. **Refer to individual system specification for allowable locations for each piping material, fitting style, and joining method. The following materials and joining may not be acceptable for certain projects and in certain areas.**

2. Provide pipe of type, joint type, grade, size and weight (wall thickness or class) as is indicated for each service in other Division 22 sections of this specification.

3. Where type, grade or class is not indicated, provide proper selection as determined by installer for installation requirements, and comply with governing regulations and industry standards

B. Pipe Fittings:

1. Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size.

2. Provide sizes and types of matching pipe for valve or equipment connections in each case.

3. Where not otherwise indicated, comply with governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable.

C. Joining Materials

1. Soldering Materials: Surface to be soldered shall be cleaned, properly fluxed and soldered with 95-5 tin-antimony solder. 50-50 and all other lead-bearing solders are prohibited.

2. Gaskets For Flanged Joints: Select materials and types to suit the service of the piping system in which they are installed. Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

3. Gaskets For Mechanical Couplings: Select materials to suit the service of the piping system in which they are installed. Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.2 COPPER PIPE AND FITTINGS

A. Type K Soft Copper: ASTM B 88 water tube, annealed temper

B. Type L Hard Copper: ASTM B 88 water tube, drawn temper

C. Type ACR Hard Drawn Seamless Copper Tube: ASTM B 819

D. Copper, Solder-Joint Fittings:

1. ASME B16.22, wrought-copper, solder-joint pressure type.

E. Copper, Pressure-Seal Fittings:

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

a. Elkhart

b. Nibco

c. Viega; Plumbing & Heating Systems.

2. NPS 2 and Smaller:

a. Wrought-copper fitting with EPDM O-ring seal in each end.

3. NPS 2-1/2 to NPS 4

a. Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

F. Copper, Grooved-Joint:

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

a. Anvil International.

b.

c. Victaulic Company.

2. Copper Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.

3. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

2.3 CAST-IRON PIPE AND FITTINGS

A. No-Hub Cast Iron Pipe: ASTM A 888 or CISPI 301.

B. Hub-and-Spigot, Cast-Iron Soil Pipe and Fittings

1. Pipe and Fittings: ASTM A 74, Service class.

2. Gaskets: ASTM C 564, rubber.

3. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

C. Hubless (No-Hub) Cast-Iron Soil Pipe and Fittings

1. Pipe and Fittings: ASTM A 888 or CISPI 301.

2. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.

3. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

a. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.

1). Acceptable Manufacturers:

a). ANACO

b). Fernco, Inc.

c). Ideal Div.; Stant Corp.

d). Mission Rubber Co.

e). Tyler Pipe; Soil Pipe Div.

2). Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.

a). Acceptable Manufacturers:

i. ANACO

ii. Clamp-All Corp.

iii. Ideal Div.; Stant Corp.

iv. Mission Rubber Co.

v. Tyler Pipe; Soil Pipe Div.

4. No-Hub Cast Iron Fittings: Comply with ASTM A 888 or CISPI 301.

5. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

a. Manufacturers:

1). Dallas Specialty & Mfg. Co.

2). Fernco, Inc.

3). Logan Clay Products Company (The).

4). Mission Rubber Co.

5). NDS, Inc.

6). Plastic Oddities, Inc.

b. Sleeve Materials:

1). For Cast-Iron Soil Pipes: ASTM C 564, rubber.

2). For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

3). For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

6. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

a. Manufacturers:

1). Cascade Waterworks Mfg. Co.

2). Mission Rubber Co.

2.4 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end, unless grooved or flanged ends are indicated.

1. Mechanical-Joint, Ductile-Iron fittings: AWWA C110, ductile – or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

2. Glands, Gaskets, and Bolts: AWWA C111, ductile – or gray-iron glands, rubber gaskets, and steel bolts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end, unless grooved or flanged ends are indicated.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile-or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

2. Gaskets: AWWA C111, rubber.

2.5 BLACK STEEL PIPE AND FITTINGS

A. Black Steel: ASTM A53 Type E, Grade B.

B. Black Steel, Threaded:

1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53 or ASTM A 106, Schedule 40, seamless steel pipe.

2. Malleable-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.

C. Black Steel, Welded:

1. Welded joints shall be provided for piping 2-1/2" and larger.

2. Schedule 40 Factory Formed, Conforming with ASME B16.

3. Flanges: ASME B16.1, Class 125, cast iron.

D. Flexible Gas Pipe Connectors

1. Acceptable Manufacturers: Subject to compliance with requirements, provide flexible gas pipe connectors as manufactured by one of the following:

a. Flexicraft

b. Hyspan Precision Products, Inc.

c. Keflex, Inc.

d. Mason Industries

e. Metraflex

E. Provide flexible gas piping connections constructed of stainless steel hose covered with stainless steel wire braid with carbon steel MPT nipples rated at minimum 150 psig working at 70°F.

2.6 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A 53, Type E, Grade B

B. Galvanized-Steel, Grooved-Joint:

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

a. Anvil International.

b. Victaulic Company.

2. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A 47/A 47M, malleable-iron casting; ASTM A 106/A 106M, steel pipe; or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.

3. Grooved-End-Pipe Couplings for Galvanized-Steel Piping: AWWA C606 for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

2.7 PVC PIPE AND FITTINGS

A. PVC Pipe: ASTM D 2665, solid wall, drain, waste, and vent

B. Schedule 40 solid wall, conforming to ASTM D 1784 for drain, waste, and vent.

C. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.

2.8 CPVC PIPE AND FITTINGS

A. CPVC Pipe: ASTM F 441

B. Schedule 40 solid wall, conforming to ASTM D 1784 for drain, waste, and vent.

C. CPVC Socket Fittings: ASTM F 438 for Schedule 40 and ASTM F 439 for Schedule 80.

2.9 POLYETHYLENE (PP) PLASTIC PIPE OR TUBING AND FITTINGS

A. PE pipe and tubing: ASTM D 2239; ASTM D 3035; CSA B137.1; ASTM D 2737

B. PE fittings: Heat fusion welded – ASTM D 2609; ASTM D 2683; ASTM D 3261; ASTM F 1055; CSA B137.1

2.10 POLYPROPYLENE (PP) PLASTIC PIPE OR TUBING AND FITTINGS

A. PP pipe or tubing: ASTM F 2389; CSA B137.11

B. PP fittings: ASTM F 2389; CSA B137.11

2.11 STAINLESS STEEL PIPE (TYPE 304/304L) AND FITTINGS

A. Stainless steel pipe and fittings: ASTM A 312; ASTM A 778

2.12 PEX PIPE AND FITTINGS

A. PEX Distribution System: ASTM F 877, SDR 9 tubing.

B. PEX, Plastic Coupling:

2.13 JOINING MATERIALS

A. Soldering Materials: Surfaces to be soldered shall be cleaned, properly fluxed and soldered with 95-5 tin-antimony solder. 50-50 and all other lead-bearing solders are prohibited.

B. Gaskets For Flanged Joints: Select materials and types to suit the service of the piping system in which they are installed. Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

C. Gaskets For Mechanical Couplings: Select materials to suit the service of the piping system in which they are installed. Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.14 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Acceptable Manufacturers:

a. Cascade Waterworks Mfg. Co.

b. Dresser Industries, Inc.; DMD Div.

c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.

d. JCM Industries.

e. Smith-Blair, Inc.

f. Viking Johnson.

2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.

3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.

4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Acceptable Manufacturers:

a. Eslon Thermoplastics.

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Acceptable Manufacturers:

a. Thompson Plastics, Inc.

D. Plastic-to-Metal Transition Unions: MSS SP-107, PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

1. Acceptable Manufacturers:

a. NIBCO INC.

b. NIBCO, Inc.; Chemtrol Div.

E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

1. Acceptable Manufacturers:

a. Cascade Waterworks Mfg. Co.

b. Fernco, Inc.

c. Mission Rubber Company.

d. Plastic Oddities, Inc.

2.15 DIELECTRIC TRANSITION FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, or flanged end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Flanges: Dielectric flanges shall include extended length high tensile studs (ASTM A193 GR.B7) with two (2) 1/16" thick mica isolating washers and two (2) nuts (ASTM A194 CR heavy series) on each side of flange, insulating bolt sleeve and raised face (Gylon 3540) insulation gasket.

1. Acceptable Manufacturers:

a. Capitol Manufacturing Co.

b. Central Plastics Company.

c. Eclipse

d. Epco Sales, Inc.

e. Perfection Corp.

f. Ricwil Piping Systems

g. Watts Industries, Inc.; Water Products Div.

D. Dielectric Nipples: Electroplated galvanized steel or brass nipple with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Acceptable Manufacturers:

a. Epco Sales, Inc.

b. Grinnell

c. Perfection Corp.

d. Precision Plumbing Products, Inc.

e. Sioux Chief Manufacturing Co., Inc.

f. Victaulic Co. of America.

2.16 JOINING MATERIALS AND METHODS

A. Grooved: Roll grooved joints per coupling manufacturer's specifications.

B. Pressed: Pressed joints per manufacturer's recommendations, using tool designed and approved specifically for use with fittings.

C. Threaded: Pipe threads shall conform to ASME B1.20.1.

D. Welding: Comply with ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

E. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-bronze flanges.

b. Narrow-Face Type: For raised-face, Class 250 steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

F. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

G. Plastic, Pipe-Flange Gasket, Bolts, and Nuts:

1. Type and material recommended by piping system manufacturer, unless otherwise indicated.

H. Solder Filler Metals:

1. ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813. 50-50 and all other lead-bearing solders are prohibited.

I. Brazing Filler Metals:

1. AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated

2. AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

J. Welding Filler Metals:

1. Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

K. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.

2. CPVC Piping: ASTM F 493.

3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

4. PVC to ABS Piping Transition: ASTM D 3138.

5. High Purity Water: System components shall be joined utilizing LE One-Step specialty solvent cement specifically formulated for joining the system that meet or exceed the requirements of ASTM D2564. The standard practice for safe handling of solvent cements shall be in accordance with ASTM F402. Solvent cement shall be listed by The National Sanitation Foundation International (NSF Intl.) for use with potable water.

L. Heat Fusion Welding

1. ASTM Standard F1056.
2. PPI Standards TR-33 and TR-41.
3. AWWA C901 and C906.
4. Local gas company requirements.

2.17 UNIONS

A. All unions shall be suitable for the temperature/pressure ratings and service in which installed. See each specific system description section of Division 22 for additional information.

Table 22 10 10.1

Pipe Material	Size	Description
Steel	2" and smaller	Malleable iron, threaded ends, ground joint brass to iron seat
	2-1/2" and larger	Weld-neck flange connections
Copper	2" and smaller	Cast brass solder ends, with machined and lapped seats
	2-1/2" and larger	Soldered-neck flange connections

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. Provide factory-applied plastic end-caps on each length of pipe and tube. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris and moisture.

B. Protect Stored Pipes: Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor or structure.

C. Protect flanges, fittings and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

3.2 SUPPORT

A. Support piping independently so as not to place a strain on valves and equipment.

B. See Section 22 12 20 - Piping Hangers and Supports for more details.

3.3 PIPING INSTALLATION

A. The Drawings indicate the general location and arrangement of the piping systems. So far as practical, install piping as indicated making connections to all equipment. Install piping as direct as possible avoiding unnecessary offsets. However, if offsets are required in order to obtain maximum headroom or to avoid conflict with other work, they shall be made as required or as requested by the Engineer without additional cost to the Owner. The Engineer reserves the right to make minor changes in the location of piping and equipment during the roughing-in, without additional cost to the Owner. All changes proposed by others shall be approved by the Engineer.

B. Install piping, requiring insulation, a sufficient distance from wall, ceiling, structure, other pipes, etc. to permit the application of the full thickness of insulation specified.

C. Install piping free of sags or bends. Support piping independently so as not to place a strain on valves and equipment.

D. Where piping is installed above accessible ceilings, allow sufficient space between ceiling and pipe to remove ceiling panels. Consideration must be given for insulation thickness.

E. Locate piping installed parallel to each other with adequate space for servicing of valves where applicable.

F. Any piping resting on or coming in contact with building structure shall be insulated at that point to prevent transmission of vibration.

G. All piping systems must be installed so they can be completely drained. Provide tee fitting, ball valve with hose thread fitting and cap at all low points, trapped sections, bases of risers, and on equipment side of shut off valves to permit draining. All drain valves shall be accessible.

H. All piping shall be installed parallel with, or at right angles to, the building walls. All vertical risers shall be installed plumb and straight. Diagonal runs are not permitted unless expressly indicated on the drawings.

I. Install all piping with reduction in size being made only at the inlet or outlet of the control valve, reducing or regulating valve, equipment or fixture. All check valves, strainers, shut-off valves, etc. shall be installed full line size.

J. Make reductions in piping with a reducing coupling or weld fitting reducer. Bushings are not permitted.

K. Taps shall be provided as necessary to permit the installation of thermometers, pressure gauges, etc. Taps shall be similar to branch connections.

L. Pipe relief valve discharges, etc. down to the floor or nearest floor drain where indicated. Drain piping shall terminate with a plain, unthreaded end.

M. Install dielectric transition fittings between dissimilar metal pipes.

N. Factory formed long radius elbows shall be utilized for all changes in direction. Mitering of pipe to form elbows is not permitted. Pipe bending is not acceptable.

O. Make branch connections in threaded or soldered piping with factory formed fittings. Notching of straight runs of pipe to form tee connections is not permitted.

P. Install appropriate dielectric transition fittings between piping of different materials.

Q. Bullhead connections in any piping system are prohibited.

R. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.

S. Install underground PVC soil and waste drainage piping according to ASTM D 2321.

3.4 JOINTS

A. After cutting, ream ends of piping and remove all burrs. Remove all scale, slag dirt and debris from both inside and outside of piping and fittings before assembly. Swab if necessary for thorough cleaning.

B. Pipe to be threaded shall be cut square and fully threaded with tapering threads. Apply pipe joint compound to male thread end of all threaded joints. Joint compound shall be compatible with the service of the piping.

C. The edges of pipe to be welded shall be machine beveled wherever possible. Before welding, the surfaces shall be thoroughly cleaned. The piping shall be carefully aligned. No metal shall project within the pipe.

D. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

E. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook for lead and oakum calked joints.

F. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

G. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux, ASTM B 32, lead-free alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

H. Grooved Joints: Assemble joint with keyed coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

I. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 EXPANSION

A. Piping shall be cut accurately to measurement at the site and worked into place without springing or forcing. Sufficient offsets, expansion loops or expansion joints between anchor points shall be provided as required, whether or not shown, to limit stresses and control movement of piping subject to the thermal expansion.

B. Make hot water branch connections from mains to fixtures and heating equipment with at least two (2) 90 degree elbows.

C. Supplement all loops, joints, compensators, etc. with adequate guides to preserve alignment and pitch.

D. Securely attach pipe guides to the building structure.

E. Provide securely supported pipe anchors as required to control expansion and contraction in piping.

3.6 ESCUTCHEONS

A. Fit all pipe passing exposed through walls, floors or ceilings in finished rooms with brass escutcheons. Include wall penetrations beneath lavatories and sinks, and beneath cabinets/counters. Where adjacent surface is to receive a paint finish, prime paint escutcheons, otherwise escutcheons shall be chrome plated. Where piping is insulated, fit escutcheons outside insulation.

3.7 CLEANING

A. After piping installation is complete and before final connections to equipment are made, thoroughly flush the piping system with a material/detergent that is not injurious to the pipe, to remove all pipe dope, oils, welding slag, scale and other extraneous material.

B. After flushing, clean all strainers, traps and dirt legs.

C. See each specific system description section of Division 22 for additional cleaning requirements.

END OF SECTION 22 10 10

SECTION 22 10 20
DRAIN, WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies piping materials and installation methods common to more than one section of Division 22 and includes fittings, joining methods and basic piping installation instructions. Portions of this Section may not be required in this project. **Only the piping materials specified in this section shall be utilized for this project.** Similarly, other items in the Section might be superseded by more specific requirements in other sections that detail specific systems. See drawings and each specific system description section of Division 22 for specific sizes, materials and installation methods pertaining to this project.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all piping work described in this Section.

1.3 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 GENERAL

A. All piping shall be constructed of materials and joined together as indicated in the following table and as specified in the following sections:

2.2 PIPE AND FITTING TABLE

A. The table below identifies the acceptable pipe materials, fitting types, and joint methods allowed for each pipe service and size. Where multiple options are listed, the option used shall be at the discretion of the Contractor.

Service	Size	Pipe Material	Fittings	Type of Joint
Above Ground Storm and Sanitary Drain, Waste, and Vent (includes pumped sanitary and storm)	All	Service Weight No Hub Cast Iron	Factory Formed Service Weight Cast Iron DWV fittings	Elastomeric sleeves with stainless steel clamps. Couplings shall comply with "CISPI 310". The elastomeric sealing sleeve shall conform to "ASTM C564" and shall be provided with a center stop.
Below Ground Storm and Sanitary Drain, Waste, and Vent (includes pumped sanitary and storm)	All	Service weight hub and spigot cast iron	Factory Formed Cast Iron DWV fittings	Compression Gasket
		Schedule 40 PVC	Factory formed schedule 40 PVC	PVC solvent cement

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Installation shall conform to all requirements in "Common Piping Requirements" section of these Division 22 Specifications.

B. Install all drain and vent lines as direct as possible. Actual locations shall meet the various building conditions and shall not conflict with ductwork or piping of other trades. Any work necessary to conceal piping shall be done as directed by the Architect.

C. Branch soil and waste pipes shall have a slope or incline of at least 1/4" per foot of run and main house drain shall slope a minimum of 1/8" per foot: Storm drains shall slope at a minimum of 1/4" per foot, unless otherwise noted. Vent pipes, where not vertical shall have a continuous slope. Pipe shall grade downward in the direction indicated on drawings. All pipe lines shall be correctly aligned before joints are made. All changes of direction in drainage and vent piping shall be made by means of factory-formed "Y" branches and factory-formed 1/6, 1/8, or 1/16 bends. All horizontal vent piping shall be installed with a continuous slope toward the connection to the drain piping. Traps in the vent piping are not permitted.

D. Make changes of direction in horizontal drain piping with bends of not more than 45°. Where change of direction is greater than 45°, install wye fitting with required bends and clean-out. Sanitary tees are not permitted in horizontal changes of direction. Avoid all unnecessary offsets.

E. Sanitary tees are not permitted in vertical to horizontal changes of direction.

F. Sanitary tees are permitted in horizontal to vertical changes of direction. Double sanitary tees are permitted in horizontal to vertical changes of direction except to receive the discharge of back-to-back water closets.

G. Provide clean-outs at the base of all stacks and vertical storm leaders; at changes of direction in horizontal drain piping greater than 45° and as shown on the drawings. Provide clean-outs in horizontal straight runs of piping at intervals not over 50'. Install clean-outs wherever storm sewers and sanitary sewers exit the building.

H. Clean-outs in concealed piping or piping below the floor shall be extended through and terminate flush with the finished floor above.

I. Clean-outs shall be the same size as the pipe to which they are connected up to 4". Pipes larger than 4" shall have a 6" clean-out. Install all clean outs with required clearance for rodding.

J. Provide drainage piping for all plumbing equipment requiring drainage. This shall include drain piping from ice machines. Insulate drainage pipe with flexible elastomeric insulation.

K. Unless noted otherwise, provide all floor drains with traps.

L. Vent terminals shall be terminated at least 12 inches above roof. Each PVC or ABS vent terminal shall be made water tight with the roof by using a rubber boot with base not less than 16" diameter and collar full height of pipe. Each steel pipe vent terminal shall be made water tight with the roof by using lead sheet (3 lb. psf) or sheet copper (8 oz. psf) with base not less than 16" diameter and collar full height of pipe. Where vents are 4" or larger, flashing may be turned over into top of pipe without gap. Furnish boot or flashing to General Contractor for building into roofing material.

M. Underground storm and sanitary sewers shall be laid with full length of each section resting on a solid bed. Where necessary to obtain a firm support, the pipe shall be bedded on select material and thoroughly tamped. Pipe shall be laid starting at the up grade and spigot end of Bell and Spigot pipe pointing in the direction of flow. As pipe is laid, care shall be exercised to keep interior of pipe clear of foreign matter. Where trenching for pipe is excessively wide, the Contractor shall, at his own expense, embed the pipe in concrete to support the added load of backfilling.

N. All excavations for installation of pipe shall be open trench work and shall be kept open until piping has been inspected, tested, and accepted.

O. Any metal piping laid in corrosive fill shall be encased in concrete or in split tile. All sewers greater than 14 feet below finish grade shall be encased in concrete.

P. Install buried piping inside the building between wall and floor penetrations and connections to sanitary sewer piping outside the building with restraint joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.

Q. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

R. Install CPVC and PVC soil and waste drainage and vent piping according to ASTM D 2665.

S. Install underground CPVC and PVC soil and waste drainage piping according to ASTM D 2321.

3.2 JOINTS

A. After cutting, ream ends of piping and remove all burrs. Remove all scale, slag dirt and debris from both inside and outside of piping and fittings before assembly. Swab if necessary for thorough cleaning.

B. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

C. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.

D. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

E. Hubless (No-hub) cast iron joint couplings shall comply with "CISPI 310". The elastomeric sealing sleeve shall conform to "ASTM C564" and shall be provided with a center stop. Mechanical joint couplings shall be installed in accordance with the manufacturer's installation instructions.

3.3 CLEANING

A. After piping installation is complete and before final connections to equipment and fixtures are made, thoroughly flush the piping system with a material/detergent that is not injurious to the pipe, to remove all shavings, pipe dope, oils, welding slag, scale and other extraneous material.

3.4 TESTING

A. All plumbing piping systems specified herein shall be air tested or hydrostatically tested per the "Piping Systems Integrity Verification" section of Division 22 Specifications.

END OF SECTION 22 10 20

SECTION 22 10 30
DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

C. Refer to Section 22 10 10 for Common Piping Requirements.

1.2 SCOPE

A. This Section specifies piping materials and installation methods for domestic water system piping and includes fittings, joining methods and specific piping installation instructions. **Only the piping materials specified in this section shall be utilized for this project.**

B. Provide all materials, equipment, labor and supervision necessary to install and perform all piping work described in this Section.

1.3 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 GENERAL

A. All piping shall be constructed of materials and joined together as specified in the following sections.

2.2 PIPE AND FITTING TABLE

A. The table below indentifies the acceptable pipe materials, fitting types, and joint methods allowed for each pipe service and size. Where multiple options are listed, the option used shall be at the discretion of the Contractor.

Table 22 10 30.1

Service	Size	Pipe Material	Fittings	Joint Method*
Domestic Water Inside the Building (Cold, Hot, and Hot Re-circulated)	4” and smaller	Type L Hard Copper	Wrought Copper Factory Formed	S
	4” and smaller	Type L Hard Copper	Wrought Copper Factory Formed	P
	6” and larger	Schedule 40 galvanized	Galvanized	G
	6” and larger	Schedule 10 Stainless Steel	Stainless Steel	G
Drain Piping and Trap Primer (Above Ground)	All sizes	Type L Hard Copper	Wrought Copper Factory Formed	S
	All sizes	Cross-linked Polyethylene (PEX)	Not Allowed	Not Allowed

Trap Primer (Below Ground)	All sizes	Type K Soft Copper Tube	Not Allowed	Not Allowed
	All sizes	Cross-linked Polyethylene (PEX)	Not Allowed	Not Allowed
*Joint Methods: G=Grooved, P=Pressed, S=Soldered				

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall conform to Section 22 10 10 - Common Piping Requirements.

B. All piping systems must be installed so they can be completely drained. Provide tee fitting, ball valve with hose thread fitting and cap at all low points, trapped sections, bases of risers, and on equipment side of shut off valves to permit draining. All drain valves shall be accessible. All piping shall be installed parallel with, or at right angles to, the building walls. All vertical risers shall be installed plumb and straight. Diagonal runs are not permitted unless expressly indicated on the drawings.

C. Install all piping with reduction in size being made only at the inlet or outlet of the control valve, reducing or regulating valve, equipment or fixture. All check valves, strainers, shut-off valves, etc. shall be installed full line size.

D. Make reductions in piping with a reducing coupling or soldered weld fitting reducer. Bushings are not permitted.

E. Factory formed long radius elbows shall be utilized for all changes in direction. Mitering of pipe to form elbows is not permitted. Pipe bending is not acceptable.

F. Make branch connections in threaded or soldered piping with factory formed fittings.

G. Taps shall be provided as necessary to permit the installation of thermometers, pressure gauges, etc. Taps shall be similar to branch connections.

H. Pipe relief valve discharges, etc. down to the floor or nearest floor drain where indicated. Drain piping shall terminate with a plain, unthreaded end.

I. Install appropriate dielectric transition fittings between piping of different materials.

J. Bullhead connections in any piping system are prohibited.

K. “Dead-Legs” in any piping system are prohibited.

L. Unless noted otherwise, make final water connections to all plumbing fixtures and equipment. This shall include coffee makers, refrigerators, ice machines, washers, etc.

3.2 EXPANSION

A. Piping shall be cut accurately to measurement at the site and worked into place without springing or forcing. Sufficient offsets, expansion loops or expansion joints between anchor points shall be provided as required, whether or not shown, to limit stresses and control movement of piping subject to the thermal expansion. Allow 1-1/4" per 100 feet of length for expansion in domestic hot water lines.

B. Make branch connections to domestic hot water risers with at least two (2) 90 degree elbows.

C. Supplement all loops, joints, compensators, etc. with adequate guides to preserve alignment and pitch.

D. Securely attach pipe guides to the building structure.

E. Provide securely supported pipe anchors as required to control expansion and contraction in piping.

3.3 CLEANING

A. After piping installation is complete and before final connections to equipment and fixtures are made, thoroughly flush the piping system with a material/detergent that is not injurious to the pipe, to remove all pipe dope, oils, slag, scale and other extraneous material.

B. After flushing, clean all strainers.

C. See each specific system description section of Division 22 for additional cleaning and disinfection requirements.

3.4 TESTS

A. All plumbing piping systems specified herein shall be hydrostatically tested per Section 22 03 10 "Piping Systems Flushing and Testing."

3.5 DISINFECTION

A. All plumbing piping systems specified herein shall be disinfected per Section 22 03 10 "Piping Systems Flushing and Testing."

END OF SECTION 22 10 30

SECTION 22 10 31
WATER SERVICE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

C. Refer to Section 22 10 10 for Common Piping Requirements.

1.2 SCOPE

A. This Section specifies piping materials and installation methods for water service piping and includes fittings, joining methods and specific piping installation instructions.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all piping work described in this Section.

C. See drawings and each specific system description indicated herein for specific sizes, materials and installation methods pertaining to this project. Portions of this Section may not be required for this project.

D. Water service piping shall be defined as all piping from the source main up to the facility's main backflow prevention device. This includes piping around meter setting.

E. The Contractor is responsible for obtaining all permits, paying all fees, and following all requirements associated with the permits.

F. The Contractor shall be responsible for notifying the Ohio Utility Protection Service (OUPS) as required by law.

G. The Water Department shall tap the water main whenever there is a tapping sleeve called for on the plans. The Contractor shall furnish all necessary parts, excavate and expose the water main and install the sleeve and valve on the main, and backfill as required.

1.3 CODES AND STANDARDS

A. Water Department/Fire Department/Marshal Compliance:

1. Furnish and install water service piping systems in accordance with regulations required by the local Water Department, local Building Department and local Fire Departments.

B. All combination fire protection/domestic water service piping systems shall be installed in accordance with National Fire Protection Association Standards 13 and 24 requirements as applicable.

C. All on-site water line piping and appurtenances shall be installed according to the local Water Department specifications and must be inspected and approved by the Water Distribution Division prior to backfilling.

D. The Water Department shall tap the water main wherever there is a tapping sleeve called for on the plans. The Contractor shall furnish all necessary parts, excavate and expose the water main and install the sleeve and valve on the main, and backfill as required.

1.4 SUBMITTALS

A. Shop Drawings: Provide Shop Drawings, per requirements of Sections 22 01 10 and 22 01 20.

B. Operation and Maintenance (O&M) Manuals: Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 GENERAL

A. All piping shall be constructed of materials and joined together as specified in the following sections.

2.2 PIPE AND FITTING TABLE

A. The table below identifies the acceptable pipe materials, fitting types, and joint methods allowed for each pipe service and size. Where multiple options are listed, the option used shall be at the discretion of the Contractor.

B. Pipe schedules refer to ANSI B36.

C. Pipe sizes refer to Nominal Pipe Sizing (NPS) standards.

Table 22 10 31.1

Service	Size	Pipe Material	Fittings	Joint Method*
Water Service	2" and smaller	Type K Copper	Wrought Copper Factory Formed	F
	2-1/2" and larger	AWWA C151 Class 53 ductile iron with ANSI/AWWA C104/A21.4 cement lining. Provide labeled polyethylene encasement per AWWA C105.	Class 350 ductile iron compact fittings per AWWA C153 or full thickness castings per AWWA C110, with mechanical joint ends and ductile iron follower glands.	
*Joint Methods: F=Flared, PO=Push-On				

2.3 PIPE JOINT MATERIALS

A. Push-on joints (Tyton, Bell-Tite, etc.), per AWWA C151 specifications with plain or restraining rubber gaskets per AWWA C111 specifications.

2.4 RESTRAINED PIPE SYSTEMS

A. Push-on joint with Field Lock (4 through 12 inch only) or Fast Grip gaskets (4 through 12 inch only), or mechanical joint with restrained follower glands, and 6 ounce zinc anode caps on every other bolt thread. Super Lock, TR Flex or Flex-Ring required on all 16 inch or larger pipe diameters.

2.5 RESTRAINED FITTING DEVICES

A. All valves, bends, offsets, hydrant inlets, caps, plugs, and branches of tees and wyes must be restrained using mechanical joint with restrained follower glands or restraining gaskets. Hardwood blocking is required for all diameters 12 inch and larger. Concrete blocking is required on all fire lines and on all diameters in areas over 100 psi. Restrained joints for diameters 12 inch and under shall be installed for a length of 30 feet on each side of a valve, bend or offset using Field-Lock or Fast-Grip restraining gaskets or mechanical joint with restrained follower glands. Restrained joints for diameters 16 inch and larger, shall be installed for a length of 30 feet on each side of a valve, bend or offset using mechanical joint with restrained follower glands.

2.6 MECHANICAL JOINT T-HEAD BOLTS

A. All mechanical joints shall be made with Cor-Ten or construction-grade alloyed ductile iron bolts. T-head bolts shall be ½ inch longer than standard length and must include a 6 oz. zinc anode cap on every other bolt thread.

2.7 GATE VALVES

A. Provide a resilient-seat wedge (RSW) valves with restrained mechanical joints. Valves shall have non-rising stems and shall open to the right (clockwise).

2.8 VALVE BOXES

A. Provide only Bibby or Bingham and Taylor brands acceptable for compatibility.

2.9 CURB STOPS

A. Curb valves (stops) shall be a one piece design, cast from a brass alloy, conforming to ANSI/AWWA C800, have a maximum working pressure of 175 psig, and have a quarter turn check. Both ends shall have copper flare nuts. Curb valves shall be buried to a minimum depth of 4 feet and a maximum depth of 5 feet.

1. Curb boxes shall be cast iron, two piece screw type, adjustable to a total height between 48 inches to 60 inches. Lids shall be cast iron with the word "WATER" cast into the top. Lids shall be secured with one brass pentagonal head screw. All boxes shall be located where shown on the plans or as directed by the water department.

2.10 CORPORATION STOPS

A. Corporation stops shall be a ground key design, cast from brass alloy, conforming to ANSI/AWWA C800. Inlet end shall have AWWA taper threads; outlet end shall have a copper flare quarter bend connection.

1. All water service taps, 2" or less shall be tapped on top of the water main. The corporation stops and quarter bend shall be blocked.

2.11 TAPPING SLEEVES

A. Tapping sleeves shall have a stainless steel body with a ductile iron flanged outlet which complies with ANSI B16.1, Class 125 and with MSS SP60. The gasket shall completely surround the inside of the stainless steel body. The sleeve shall come equipped with a ¾" NPT brass test plug. Maximum working pressure for 4" – 12" sizes (250 psig) and for 14" – 24" sizes (200 psig).

2.12 TAPPING VALVES

A. Tapping valves shall meet or exceed all applicable requirements of ANSI/AWWA C509. The inlet flange shall comply with ANSI B16.1, Class 125 drilling. The mechanical joint outlet shall comply with ANSI/AWWA C111. The valve shall have a non-rising stem (NRS). The operating nut shall be 2" square, which opens to the left. Valves shall come equipped with a double o-ring seal stuffing box and have an epoxy coating on all exterior surface which complies with AWWA C550.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Refer to Division 22 Section "Common Piping Requirements" for basic piping installation.

B. All underground pipe shall be installed with 4 feet 6 inches of cover. See detailed water department specifications for approved pipe, fittings, bolts, etc., for water line installation.

C. Maintain a 12 inch minimum vertical clearance from edge of water line to edge of storm sewers and/or inlet lead where they cross.

D. Maintain a 4 foot minimum horizontal clearance from edge of water line to edge of storm sewer.

E. Maintain a 10 foot horizontal clearance from edge of water line to edge of sanitary sewer.

F. Maintain an 18 inch minimum vertical clearance from edge of water line to edge of sanitary sewer where they cross.

G. Maintain a 12 inch vertical clearance from edge of water line to edge of gas, electric, etc.

H. Maintain a 5 foot minimum horizontal clearance from edge of water line to edge of gas lines(s), electric line(s), communication line (s), etc.

I. In buildings with interior meter setting without basements, water service line must be installed in an AWW approved conduit from one foot outside footer to above floor slab.

J. Buildings with interior meter settings not on outside wall, the water service line must be installed in a continuous AWW approved conduit from outside building footer up through floor slab.

K. Water service line installed under paved areas for inside meter setting must be in an AWW approved conduit from street right-of-way to inside building.

3.2 TESTING

A. Piping systems specified herein shall be tested per the "Piping Systems Integrity Verification" section of Division 22 Specifications.

3.3 CLEANING AND PURGING

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

1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.

2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water unit dirty water does not appear at points of outlet.

3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:

a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.

b. Drain system or part of system of previous solution and refill with water /chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.

c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.

d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

4. Prepare reports of purging and disinfecting activities.

END OF SECTION 22 10 31

SECTION 22 10 40
NATURAL GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

C. Refer to Section 22 10 10 for Common Piping Requirements.

1.2 SCOPE

A. This Section specifies piping for natural gas systems installed inside or outside above grade and outside below grade, and includes materials, testing and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 PIPE AND FITTING TABLE

A. The table below identifies the acceptable pipe materials, fitting types, and joint methods allowed for each pipe service and size. Where multiple options are listed, the option used shall be at the discretion of the Contractor.

B. Pipe schedules refer to ANSI B36.

C. Pipe sizes refer to Nominal Pipe Sizing (NPS) standards.

Table 22 10 40.1

Service	Size	Pipe Material	Fittings	Joint Method*
Interior and Exterior Above-Ground	2” and smaller	Schedule 40 Black Steel	150 psig, working pressure, malleable iron, screwed type	T
	2-1/2” and larger	Schedule 40 Black Steel	Factory formed welding fittings	W
Gas Vent	2” and smaller	Schedule 40 Black Steel	150 psig, working pressure, malleable iron, screwed type	T
	2-1/2” and larger	Schedule 40 Black Steel	Factory formed welding fittings	W
Gas Vent	2” and smaller	Type “L” Hard Copper	Factory formed fittings	S
	2-1/2” and larger	Type “L” Hard Copper	Factory formed fittings	S
*Joint Methods: T=Threaded, W=Welded, S=Soldered				

2.2 UNDERGROUND PIPING

A. Acceptable Manufacturers:

1. Subject to compliance with these specifications, underground gas piping shall be as manufactured by one of the following:

a. Cheveron Phillips

b. Drisco

c. Plexco

d. Polypipe

B. Pipe shall be high density PE 3408 SDR11 polyethylene pipe with fusion joints as approved by the local gas company. Tubing and fittings shall be manufactured in accordance with the latest edition of ASTM D2513. Fittings shall be socket fused type meeting ASTM D2683 and marked as required by ASTM D2513.

PART 3 - EXECUTION

3.1 GENERAL

A. Install at piping as shown on the drawings with connections made to all equipment as indicated.

B. Provide a line size shut-off valve, union and tee with full sized dirt leg (sediment trap) at all equipment connections. Reduce pipe size only at equipment connection. Lubricate all valves before putting the valves into service.

C. Piping shall not be installed through ductwork, laundry or clothes chutes, elevator shafts, and chimneys.

D. Piping shall not be installed in solid partition walls unless a chase or casing is provided.

E. Portions of gas piping systems installed in concealed locations (i.e., inside stud walls or above drywall ceiling) or within return air ceiling plenums, shall not contain unions or shut-off valves. All gas valves shall be accessible. Elbows, tees and couplings are permitted.

F. Gas piping shall not be used as a grounding electrode.

G. Bushings shall not be utilized.

H. Cast iron fittings shall not be utilized.

I. Galvanized pipe or fittings shall not be utilized.

J. Provide ½" elastomeric insulation around all piping in walls and through floors.

K. Provide taps as necessary for installation of pressure gauges.

L. Extend gas vent piping through an exterior wall, elbow downward, increase open pipe discharge two pipe sizes larger than vent size, and cover open discharge pipe with a stainless steel insect screen.

M. Provide yellow insulated, continuous underground 12 gauge copper tracer wire to mark underground gas pipe. Provide tracer wire directory overtop of underground non-metallic pipe. Tracer wire shall not be wrapped around plastic pipe. Tracer wire shall terminate above ground at wall bracket. Include identification tape: yellow with black lettering "Natural Gas".

N. All black steel pipe and fittings exposed to the outdoors shall be painted with primer, and then two coats of rust inhibited paint-color as selected by the Architect.

3.2 INSPECTION, TESTING, AND PURGING

A. All gas piping systems shall be inspected and pressure tested. Testing procedure shall conform to the local gas utility requirements and the latest "International Fuel Gas Code".

B. Test pressure shall be 1-1/2 times the proposed maximum working pressure, but not less than 3 psi, irrespective of design pressure. Test medium shall be air or an inert gas (OXYGEN SHALL NEVER BE USED). Test duration shall be 24 hours. Prior to testing, the interior of the pipe shall be cleared of all foreign material.

C. All testing shall be done with due regard for the safety of employees and the public.

D. After a successful pressure test and before the system is placed in operation, the piping system shall be purged in accordance with NFPA 54 "National Fuel Gas Code". The point of discharge shall not be left unattended during purging. After the piping has been placed in operation, all equipment shall be purged and then placed in operation, as necessary.

END OF SECTION 22 10 40

SECTION 22 10 51
LABORATORY VACUUM PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

C. See other Division 22 Specifications for laboratory vacuum outlets, alarms, valves, testing and verification requirements.

1.2 SCOPE

A. This Section specifies laboratory vacuum system piping and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. All materials, equipment and the installation shall be in accordance with the current version of the applicable building code.

B. Installation shall comply with the Pressure Piping Systems Code including obtaining a permit and inspection as required.

1.4 DELIVERY, STORAGE AND HANDLING

A. Protect Stored Pipes: Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor or structure.

B. Protect flanges, fittings and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

C. Provide factory-applied plastic end-caps on each length of pipe and tube. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris and moisture.

1.5 QUALITY ASSURANCE

A. Aluminum Alloy Tubing

1. The distribution system must be of an all metal push-connect design as supplied by Champion Air Compressor or equivalent.

2. All components must be manufactured to ISO 9001: 2000 quality standards.

3. The system must be tested in accordance with the requirements of ANSI B31.1 (American National Standards Institute) power piping systems.

4. The system must comply with directive 97/23/CE Art 3.3 (PED: pressure equipment directive).

1.6 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 GENERAL

A. All piping shall be constructed of materials and joined together as specified in the following sections.

2.2 PIPE AND FITTING TABLE

A. The table below identifies the acceptable pipe materials, fitting types, and joint methods allowed for each pipe service and size. Where multiple options are listed, the option used shall be at the discretion of the Contractor.

B. Pipe schedules refer to ANSI B36.

C. Pipe sizes refer to Nominal Pipe Sizing (NPS) standards.

Table 22 10 51.1

Service	Size	Pipe Material	Fittings	Joint Method*
Laboratory Vacuum	All sizes	Type L copper, ASTM B819	Wrought Copper Factory Formed	B
		Aluminum Alloy Tubing	Solid brass nickel pated factory formed fittings with o-ring seals	M
*Joint Methods: B=Brazed, G=Grooved, M=Mechanical, P=Pressed, S=Soldered, T=Threaded, W=Welded				

2.3 ALUMINUM ALLOY TUBING AND FITTINGS

A. Acceptable Manufacturers:

1. Champion "Quick-Lock" Tubing
2. Engineer approved equal

B. General

1. All components shall conform:
   a. Working pressure 29.6” Hg (vacuum) to 220psi, constant across the temperature range of -20°F to +176°F.
   b. All components of the system must be compatible with all commonly known types of synthetic and mineral compressor lubricants.
   c. No plastic components (fittings) of any kind should be allowed within the pressurized system. This is applicable to both main headers and drop lines from the system

C. Tubing

1. The tubing shall be manufactured in Aluminum alloy grade 6063 T5. Tubing shall be quality controlled to meet the tolerances specified by the push connect coupling manufacturer. The tubing manufacture shall follow ISO 9001:2000 quality standards.
2. All tubing must be powder coated. Colors shall blue for Compressed air. Powder painting must be non toxic certified to UNI 9983 – BS 6496 – AAMA 603-605.

3. Each length of tubing must have identification decal attached that states the maximum working temperature and maximum working pressure. The decal must be of the size stated in ANSI B31.1.

D. Couplings

1. All fittings, 20mm through to 63mm should have bodies manufactured in solid brass and be nickel plated.

2. The fittings should use O ring seal design that utilizes a seal with high nitrile content in excess of 36%.

3. Clamping washer to be manufactured in INOX AISI 304 stainless steel

2.4 BRAZING MATERIALS

A. All copper to copper joints in the piping, except those at equipment requiring threaded connections, shall be made with silver solder or similar high melting point (at least 1,000 °F.) brazing alloy. Brazing alloys shall comply with "Specifications for Brazing Filler Metal," ANSI/AWS A5.8.

B. Brazing alloy shall be BCuP-5 Brazing alloy or equivalent alloy with at least 1000 °F melting point.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall conform to Section 22 10 10 - Common Piping Requirements.

B. Aluminum Alloy Tubing and Fitting Installation

1. Infinity tubing must be supported at a minimum of 10ft intervals utilizing clips and supports specifically designed to be used with the system.

2. All brackets must allow for expansion and contraction within the tubing system.

3. All systems should be pressure tested after installation by a competent person.

4. Testing should be conducted to meet all local codes and insurance requirements.

3.2 JOINTS

A. After cutting, ream ends of piping and remove all burrs. Remove all scale, slag dirt and debris from both inside and outside of piping and fittings before assembly. Swab if necessary for thorough cleaning.

3.3 CLEANING

A. After piping installation is complete and before final connections to equipment are made, thoroughly flush the piping system, to remove all pipe dope, oils, welding slag, scale and other extraneous material.

3.4 TESTS

A. All plumbing piping systems specified herein shall be hydrostatically tested per Section 22 03 10 "Piping System Flushing and Testing."

END OF SECTION 22 10 51

SECTION 22 10 60

ACID WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

C. Refer to Section 22 10 10 for Common Piping Requirements, and material specifications.

1.2 SCOPE

A. This Section specifies piping materials and installation methods for acid waste and vent piping and includes fittings, joining methods and basic piping installation instructions. Portions of this Section may not be required in this project. Similarly, other items in the Section might be superseded by more specific requirements in other sections that detail specific systems. See drawings and each specific system description section of Division 22 for specific sizes, materials and installation methods pertaining to this project.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all piping work described in this Section.

1.3 DELIVERY, STORAGE AND HANDLING

A. Protect Stored Pipes: Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor or structure.

B. Protect flanges, fittings and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

C. Provide factory-applied plastic end-caps on each length of pipe and tube. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris and moisture.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Ipex USA LLC.

B. Orion Fittings, Inc.

C. Spears Manufacturing

2.2 PIPE AND FITTINGS

A. The paragraphs below identify acceptable pipe materials, fitting types and joining methods allowed for this project. Where multiple options are listed, the option used shall be at the discretion of the Contractor.

B. The acid waste and vent drainage systems shall be Polyvinylidene Fluoride (PVDF) pipe and fittings, conforming to ASTM F1673. The pipe and fittings shall be joined using No-Hub/Plain End couplings. The pipe shall be supplied in factory grooved 10-ft. lengths. Fittings shall meet or exceed Schedule 40 dimensions. Each coupling shall have 300 series stainless steel outer band and 5/16" bolts, nuts and washers plated to meet a 100-hour salt spray test per ASTM B117. The PVDF material shall conform to ASTM D3222. Pipe shall be marked with UL to indicate compliance with UL723 (ASTM E84).

C. Acid waste and vent piping shall be manufactured from Chlorinated Polyvinyl Chloride (CPVC) Type IV, ASTM Cell Classification 23447. All system components shall be certified by The National Science Foundation (NSF) International for use in corrosive waste drainage systems as a Special Engineered (SE) product and bear the NSF mark. All system pipe and fittings shall be Schedule 40 CPVC produced to the dimensional requirements of ASTM F1412 and the manufacturer's specifications. All pipes shall be CAN/ULC S102.2 Listed for flame spread and smoke development with rating designated on the pipe marking. All pipe markings shall be accompanied by a yellow stripe for identification of CPVC chemical waste system. All fittings shall be CPVC drainage patterns meeting the requirements of ASTM D3311 and the manufacturer's specifications, as applicable. All fittings shall be CAN/ULC S102.2 listed for flame spread and smoke development rating designated on the original package labeling. Joining method for pipe and fittings shall be solvent cement welding. Solvent cement shall be a "one-step" primerless type CPVC cement specially formulated for resistance to corrosive chemicals and manufactured in accordance with ASTM F493. All pipe, fittings, and cement shall be supplied together as a system from the manufacturer.

D. Acid waste drain and vent piping shall be manufactured from NSF listed Type 110 or 210, Schedule 40, flame retardant Polypropylene (PP) conforming to ASTM D4101. Matched fittings shall be made from NSF listed flame retardant polypropylene. All system pipe and fittings shall be produced to the dimensional requirements of ASTM F1412 and the manufacturer's specifications. The pipe shall have an average flame spread of zero seconds and a maximum extent of burning of 13mm, and the fittings shall have a maximum burn time of 80 seconds and a maximum extent of burning of 20mm, when tested in accordance with the requirements of ASTM D635. Joining methods for pipe and fittings shall be either electrofusion or mechanical joint connections.

1. Electrofusion fittings shall have an integral heavy gauge, nickel/chrome electrical resistance wired molded in place in the fitting body. Copper wire elements, loose wire or other loose joint components protruding in the pipe, are prohibited. All electrofusion joints shall have a fusion cycle controlled by a microprocessor operated, waterproof electrofusion machine equipped with input and output voltage sensors, ambient temperature sensors to automatically adjust fusion time and audible alarms to indicate cycle interruptions and completion of the joining process. The electrofusion machine shall be third party certified by UL and CSA. Mechanical joint fittings shall be of all plastic construction and be designed to lock in the machined groove on the mating pipe. No metallic grab rings or clamps shall be allowed. The piping system shall also include recommended adapters to connect to other piping materials, where applicable. All pipe, fittings and joining tools shall be supplied together as a system from the manufacturer.

E. Acid waste drain and vent piping shall be made of a UL Classified Borosilicate glass conforming to ASTM Specification C 1053-90, Federal Specification DD-G-541-B and Military Specification MIL-P-22561-B (YD). Glass to glass connections shall be made with compression type bead-to-bead and bead-to-plain end couplings – article number 6650 and 6661 respectively. Coupling's outer shell, bolt and nut to be made from 300 series stainless steel. Bead to plain end coupling outer shell must encapsulate compression liner to prevent cold flow and ensure leak-free joint. Inner seal ring is made of tetra-fluoroethylene. System shall be installed in accordance with the manufacturer's recommendations and the governing plumbing code.

2.3 ACID NEUTRALIZATION/DILUTION TANK

A. Tank shall be constructed of High Density Polyethylene (HPPE) or Chloride (CPVC) designed to sit on the floor. Tank shall have a bolted cover and shall be filled with the proper amount of limestone. Tank capacity and inlet/outlet/vent connections shall be as detailed on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Installation shall conform to all requirements in "Common Piping Requirements" section of these Division 22 Specifications.

B. Install all drain and vent lines as direct as possible. Actual locations shall meet the various building conditions and shall not conflict with ductwork or piping of other trades. Any work necessary to conceal piping shall be done as directed by the Architect.

C. Branch waste pipes shall have a slope or incline of at least 1/4" per foot of run. Vent pipes, where not vertical shall have a continuous slope. Pipe shall grade downward in the direction indicated on drawings. All pipe lines shall be correctly aligned before joints are made. All changes of direction in drainage and vent piping shall be made by means of factory-formed "Y" branches and factory-formed 1/6, 1/8, or 1/16 bends. All horizontal vent piping shall be installed with a continuous slope toward the connection to the drain piping. Traps in the vent piping are not permitted.

D. Make changes of direction in horizontal drain piping with bends of not more than 45°. Where change of direction is greater than 45°, install wye fitting with required bends and clean-out. Sanitary tees are not permitted in horizontal changes of direction. Avoid all unnecessary offsets.

E. Sanitary tees are not permitted in vertical to horizontal changes of direction.

F. Sanitary tees are permitted in horizontal to vertical changes of direction. Double sanitary tees are permitted in horizontal to vertical changes of direction.

G. Provide clean-outs at the base of all stacks and at changes of direction in horizontal drain piping greater than 45° and as shown on the drawings. Provide clean-outs in horizontal straight runs of piping at intervals not over 50'.

H. Clean-outs in concealed piping or piping below the floor shall be extended through and terminate flush with the finished floor above.

I. Clean-outs shall be the same size as the pipe to which they are connected up to 4".

J. Install all clean outs with required clearance for rodding.

K. Vent terminals shall be terminated at least 12 inches above roof. Each vent terminal shall be made water tight with the roof by using a rubber boot with base not less than 16" diameter and collar full height of pipe. Furnish boot or flashing to General Contractor for building into roofing material.

3.2 JOINTS

A. After cutting, ream ends of piping and remove all burrs. Remove all scale, slag dirt and debris from both inside and outside of piping and fittings before assembly. Swab if necessary for thorough cleaning.

3.3 CLEANING

A. After piping installation is complete and before final connections to equipment and fixtures are made, thoroughly flush the piping system with a material/detergent that is not injurious to the pipe, to remove all pipe dope, oils, welding slag, scale and other extraneous material.

3.4 TESTING

A. All plumbing piping systems specified herein shall be hydrostatically tested per the "Piping Systems Integrity Verification" section of Division 22 Specifications.

END OF SECTION 22 10 60

SECTION 22 10 80
COMPRESSED AIR PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

C. Refer to Section 22 10 10 for Common Piping Requirements, and material specifications.

1.2 SCOPE

A. This Section specifies piping materials and installation methods for compressed air system piping and includes fittings, joining methods and specific piping installation instructions.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all piping work described in this Section.

C. See drawings and each specific system description indicated herein for specific sizes, materials and installation methods pertaining to this project. Portions of this Section may not be required for this project.

1.3 DELIVERY, STORAGE AND HANDLING

A. Protect Stored Pipes: Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor or structure.

B. Protect flanges, fittings and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

C. Provide factory-applied plastic end-caps on each length of pipe and tube. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris and moisture.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 GENERAL

A. All piping shall be constructed of materials and joined together as specified in the following sections.

2.2 PIPE AND FITTING TABLE

A. The table below identifies the acceptable pipe materials, fitting types, and joint methods allowed for each pipe service and size. Where multiple options are listed, the option used shall be at the discretion of the Contractor.

B. Pipe schedules refer to ANSI B36.

C. Pipe sizes refer to Nominal Pipe Sizing (NPS) standards.

Table 22 10 80.1

Service	Size	Pipe Material	Fittings	Joint Method*
Compressed Air	All sizes	Black Steel, schedule 40	300 psi malleable iron factory formed fittings	T
		Type L copper	Wrought Copper Factory Formed	S
		Aluminum Alloy Tubing	Solid brass nickel pated factory formed fittings with o-ring seals	M
*Joint Methods: B=Brazed, G=Grooved, M=Mechanical, P=Pressed, S=Soldered, T=Threaded, W=Welded				

2.3 ALUMINUM ALLOY TUBING AND FITTINGS

A. General

1. All components shall conform:

a. Working pressure 29.6" Hg (vacuum) to 220psi, constant across the temperature range of -20°F to +176°F.

b. All components of the system must be compatible with all commonly known types of synthetic and mineral compressor lubricants.

c. No plastic components (fittings) of any kind should be allowed within the pressurized system. This is applicable to both main headers and drop lines from the system

B. Tubing

1. The tubing shall be manufactured in Aluminum alloy grade 6063 T5. Tubing shall be quality controlled to meet the tolerances specified by the push connect coupling manufacturer. The tubing manufacture shall follow ISO 9001:2000 quality standards.

2. All tubing must be powder coated. Colors shall blue for Compressed air. Powder painting must be non toxic certified to UNI 9983 – BS 6496 – AAMA 603-605.

3. Each length of tubing must have identification decal attached that states the maximum working temperature and maximum working pressure. The decal must be of the size stated in ANSI B31.1.

C. Couplings

1. All fittings, 20mm through to 63mm should have bodies manufactured in solid brass and be nickel plated.

2. The fittings should use O ring seal design that utilizes a seal with high nitrile content in excess of 36%.

3. Clamping washer to be manufactured in INOX AISI 304 stainless steel

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall conform to Section 22 10 10 - Common Piping Requirements.

B. Aluminum Alloy Tubing and Fitting Installation

1. Infinity tubing must be supported at a minimum of 10ft intervals utilizing clips and supports specifically designed to be used with the system.
2. All brackets must allow for expansion and contraction within the tubing system.
3. All systems should be pressure tested after installation by a competent person.
4. Testing should be conducted to meet all local codes and insurance requirements.

3.2 JOINTS

A. After cutting, ream ends of piping and remove all burrs. Remove all scale, slag dirt and debris from both inside and outside of piping and fittings before assembly. Swab if necessary for thorough cleaning.

3.3 CLEANING

A. After piping installation is complete and before final connections to equipment are made, thoroughly flush the piping system, to remove all pipe dope, oils, welding slag, scale and other extraneous material.

3.4 TESTS

A. All plumbing piping systems specified herein shall be hydrostatically tested per Section 22 03 10 "Piping System Flushing and Testing."

END OF SECTION 22 10 80

SECTION 22 10 90
FLUE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies flue vents and combustion air intake piping serving fuel burning appliances and includes materials and installation requirements. Extent of work required by this Section is indicated on drawings and by requirements of this Section.

1.3 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

C. Special:

1. Submit certificates of materials compliance with specified ASTM, UL and ASHRAE requirements.

PART 2 - PRODUCTS

2.1 MATERIAL SCHEDULE

A. Provide breechings and vents per the following table:

Description	Material
Domestic Water Heater Flue Vent	Schedule 40 PVC Pipe
Combustion Air Intake	Schedule 40 PVC Pipe

2.2 PVC FLUE PIPING

A. Schedule 40 PVC plastic pipe with solvent cement PVC factory formed fittings shall be permitted to be used for venting appliances listed for use with such venting materials.

B. Install piping and terminate as required by the appliance manufacturers recommendations.

PART 3 - EXECUTION

3.1 GENERAL

A. Store delivered materials inside, out of the weather. Protect materials from accidental damage.

B. Installation shall conform to the manufacturer's installation instructions, UL listing (where applicable) and state and local codes.

3.2 VENT SYSTEM LAYOUT

A. The vent system shall be routed to maintain minimum clearance to combustibles as specified by the manufacturer.

B. Vent Installation shall conform to the manufacturer’s installation instructions, its UL listing and state/local codes.

C. The vent system and breechings shall be inspected and cleaned before the final connection to the appliances.

3.3 PVC FLUE PIPING

A. PVC flue piping shall be supported as per manufacturer's recommendations.

B. Cap all open ends of piping during construction to prevent entrance of dust, debris, etc.

C. Clean all PVC piping of dust and debris prior to final connection to appliances.

END OF SECTION 22 10 90

SECTION 22 11 10
PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies insulation materials and installation methods common to more than one section of Division 22.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all insulation work described in this Section.

1.3 QUALITY ASSURANCE

A. Installing contractor shall have at least 3 years successful installation experience on projects with mechanical insulation similar to that required for this project.

B. Insulation thickness shall meet the minimum requirements of ASHRAE Standard 90.1.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver insulation, coverings, cements, adhesives and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.

B. Protect insulation against dirt, water, chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

C. Replace damaged insulation which cannot be satisfactory repaired, including insulating with vapor barrier damaged and moisture-saturated insulation.

D. The insulation installer shall advise the General Contractor as to requirements for protection of the insulation work during the remainder of the construction period (after the installation of insulation), to avoid damage and deterioration of the finished insulation work.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Unless otherwise noted, and subject to compliance with Specifications, provide insulation materials from the manufacturers specified below:

1. Fiberglass Pipe Insulation

a. Owens Corning

b. Knauf

c. CertainTeed

d. Johns Manville

2. Closed Cell Elastomeric Insulation

a. Insul-Tube

b. K-Flex USA

c. Manson Insulation

d. Nomaco Kflex

e. Techlite Insulation

f. Thermacel

2.2 GENERAL

A. Provide all insulation materials (insulation, jackets, fitting covers, adhesives, cements, mastics, sealers and finishes) with a flame-spread index of 25 or less and smoke developed index of 50 or less, as tested under procedure ASTM E-84 (NFPA 255).

2.3 FIBERGLASS

A. Provide one-piece fiberglass pipe insulation with all-service jacket for all piping systems indicated on drawings or in other sections of this Specification.

B. Fiberglass pipe insulation shall have a "k" factor of 0.23 at a mean temperature of 75 °F.

C. Fiberglass pipe insulation shall comply with ASTM C 547 Type I.

D. Factory applied all service jacket shall be white, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

E. Apply the following fiberglass insulation thicknesses to the pipe sizes schedule:

Table 22 11 10 .1 – Fiberglass Pipe Insulation Thickness

Pipe Type	Pipe Size				
	0 to 1"	1-1/4" to 2"	2-1/2" to 4"	5" and 6"	8" and above
Domestic Cold Water Piping	1”	1”	1”	1”	1”
Domestic Hot Water Piping	1”	1”	1-1/2”	1-1/2”	1-1/2”
Horizontal Storm Conductors	1”	1”	1”	1”	1”

2.4 CLOSED CELL ELASTOMERIC INSULATION

A. Provide closed-cell elastomeric pipe insulation for all piping systems indicated on drawings or in other sections of this Specification.

B. Closed cell elastomeric pipe insulation shall comply with ASTM C 534 Type I.

C. Apply the following closed cell elastomeric insulation thicknesses to the pipe sizes scheduled:

Table 22 11 10 .2 - Closed Cell Elastomeric Insulation Thickness

Pipe Type	Pipe Size				
	0 to 1"	1-1/4" to 2"	2-1/2" to 4"	5" and 6"	8" and above
Water Cooler traps and wastes (if not factory insulated)	½”	½”	½”	½”	½”

Pipe Type	Pipe Size				
	0 to 1"	1-1/4" to 2"	2-1/2" to 4"	5" and 6"	8" and above
Trap primer piping – above and below floor	½"	½"	½"	½"	½"
Domestic Water Piping - Below Floor	½"	½"	½"	½"	½"
Floor drains, traps of floor drains, and horizontal sanitary piping receiving cooling coil condensate drainage or ice machine drainage (closed cell elastomeric sheet insulation)	1"	1"	1"	1"	1"
Domestic Cold Water Piping	1"	1"	1"	1"	1"
Domestic Hot Water Piping	1"	1"	1-1/2"	1-1/2"	1-1/2"
Horizontal Storm Conductors	1"	1"	1"	1"	1"

2.5 PVC JACKETS

A. PVC jacket shall be high-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C.

B. Provide PVC jacket on all exposed piping required to receive insulation (piping below finished ceiling; not concealed above ceilings or within walls).

2.6 ALUMINUM JACKETS

A. Jacket shall be 0.016" thick sheet aluminum.

2.7 ADA INSULATION KITS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide insulation kits as manufactured by one of the following:

1. McGuire Manufacturing Company, Inc. "ProWrap"
2. Truebro "Handi Lav-Guard"
3. Plumberex "Pro-2000" series

B. Materials

1. Insulation kits shall be a minimum of 1/8" thick molded closed cell vinyl construction with PVC satin white cover. Insulation material shall be anti-microbial/anti fugal. Provide kit with removable valve access caps.
2. Units shall be barrier-free, and shall be installed per ADA requirements and shall comply with ICC/ANSI A 117.1.

PART 3 - EXECUTION

3.1 GENERAL

A. Install insulation products according to manufacturer's printed instructions, in compliance with recognized industry standards and this specification.

B. Install all insulation over clean, dry surfaces. Insulation must be dry and in good condition. Wet or damaged insulation is not acceptable.

C. Install all insulation only after the completion of system pressure tests and leakage tests and installation of piping heat trace.

D. Install insulation materials with smooth even surfaces. Use full lengths of insulation where possible, only cut where necessary. Do not use cut pieces or scraps abutting each other.

E. Repair existing pipe and equipment insulation where removed to make new connections, to add controls, or where damaged by new construction. Use same insulation as specified for new service.

F. Where existing asbestos insulation is discovered or suspected – notify the building Owner immediately so it can be removed under a separate asbestos removal contract.

3.2 PIPING INSULATION

A. On exposed piping, locate insulation and cover seams in least visible locations.

B. Install piping insulation continuous through all wall, floor and ceiling penetrations, sleeves and pipe hanger locations.

C. Install fiberglass pipe insulation with joints butted firmly together. Seal jacket laps with butt strips, having factory applied adhesives. **Insulate all valves and fittings using mitered sections of insulation or premolded fitting insulation.** Cover valves and fittings with the same type and density of insulation as used on the piping. Do not cover valve bonnets, unions and strainers with insulation except for domestic cold water piping systems.

D. Taper all fiberglass insulation ends, seal and cover with glass cloth regardless of service. Where vapor barrier jackets are used on cold surfaces, apply insulation with vapor seal integrity maintained throughout the entire system. Staples shall not be used on any cold piping systems.

E. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints. For cold piping, apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3" wide vapor barrier tape or band.

F. Apply the manufacturer's recommended adhesive for closed-cell elastomeric pipe and sheet insulation based on the working temperature of service.

3.3 ADA INSULATION KITS

A. Install on all exposed hot water, cold water and drain piping under wall mounted plumbing fixtures.

3.4 PROTECTION

A. Replace damaged insulation which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.

B. The insulation installer shall advise the General and Plumbing Contractors as to requirements for protection of the insulation work during the remainder of the construction period (after the installation of insulation), to avoid damage and deterioration of the finished insulation work.

END OF SECTION 22 11 10

SECTION 22 12 10
PIPING IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies mechanical system piping identification and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. All pipe markers shall conform to ANSI A13.1 – 1996 "Scheme for the Identification of Piping Systems".

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

C. Schedules: Submit valve schedule for each piping system. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space) and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses by special "flags" in margin of schedule. After review and approval of valve schedule, furnish extra laminated copies for Maintenance Manuals as specified in Division 1. Valve numbering sequence shall follow the format of the Owner's existing system.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide identification products as manufactured by one of the following:

1. Brady Corporation
2. Brimar Industries, Inc.
3. Craftmark Identification Systems.
4. DuraLabel/Graphic Products
5. Identification Depot
6. Kolbi Pipe Marker Co.
7. Marking Services, Inc.
8. Seton Identification Products.

2.2 PIPE MARKERS

A. Colored, precoiled plastic, designed to install without the need for tape or a band. Markers to include flow direction arrows and lettering describing pipe's contents. Markers shall provide 360° visibility.

B. Markers for installation on piping with outside diameter less than 6" (including insulation) shall be snap-around type. Markers for installation on piping with outside diameter 6" or greater (including insulation) shall be strap-around type.

C. Marker colors and wording for each specific piping system shall be as follows:

Table 22 12 10.1

Marker Wording	Background/Lettering
Acid Vent	Yellow/Black
Acid Waste	Yellow/Black
Carbon Dioxide	Grey/White
Compressed Air	Blue/White
Deionized Water	Green/White
Domestic Cold Water	Green/White
Domestic Hot Recirculation	Yellow/Black
Domestic Hot Water (110°F)	Yellow/Black
Domestic Hot Water (140°F)	Yellow/Black
Medical Air	Yellow/Black
Medical Vacuum	White/Black
Natural Gas	Yellow/Black
Nitrogen	Black/White
Nitrous Oxide	Blue/White
Oxygen	Green/White
Reverse Osmosis	Green/White
Soft Water	Green/White
Storm Sewer	Green/White

2.3 VALVE TAGS

A. Brass valve tags, 1-1/2" diameter round with black fill letters and numbers. 19 gauge brass with 3/16" top hole.

B. Valve tags shall have a 1/4" high "PLBG" label.

C. Each system shall be consecutively numbered, starting with "1", with 1/2" high numbers.

D. Valve tags shall be attached to each valve with a non-rusting ring or chain.

2.4 CEILING MARKERS

A. Ceiling markers shall be provided for all shut off valves concealed above ceiling that serve more than six fixtures. Ceiling markers shall be 1" diameter white sticky tags with ¼" green lettering abbreviated as follows:

Piping Valve Serves	Abbreviation – followed by valve tag number
Domestic Cold Water	DCW – xxx
Domestic Hot Water	DHW - xxx
Domestic Hot Water Recirc	RHW - xxx

Softened Cold Water	SCW - xxx

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in plumbing identification work with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated in coordination with the Owner or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of plumbing systems and equipment.

3.3 PIPE MARKER INSTALLATION

A. General: Install pipe markers on each system indicated under piping identification schedule and include arrows to show normal direction of flow. Install on pipe insulation segment where required for hot non-insulated pipes.

B. Install pipe markers at the following locations:

1. Adjacent to valves.
2. Where pipes pass through walls, on both sides of wall.
3. Where pipes pass through floor, above floor, within two feet of floor level.
4. Near all branches and changes in direction.
5. At 20 foot intervals on straight runs of pipe.
6. At access door locations.

3.4 VALVE TAGS INSTALLATION

A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude valves within factory-fabricated equipment units, shut off valves to individual plumbing fixture faucets, convenience and lawn-watering hose bibs and angle stops at plumbing fixtures and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.

B. All shut-off and balancing valves shall be tagged except local valves adjacent to an equipment item or fixture.

C. At the completion of the project, provide a valve directory for each system. Include a copy of each directory in the Operating and Maintenance Manual. Coordinate the valve designation/numbering system with the Owner. Directory shall include valve designation/number, service, building location, size and equipment/fixtures controlled.

D. Accurately record valve tag numbers and locations on the "Record Drawings".

3.5 CEILING MARKERS INSTALLATION

A. Ceiling markers shall be in close proximity to the valve that it tags. Ceiling markers shall be installed on the tee bars of layin ceilings, but not on the main runs.

END OF SECTION 22 12 10

SECTION 22 12 20
PIPING HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies piping hanging and supporting methods common to more than one section of Division 22 and includes hangers, supports, saddles, shields, clamps, inserts, and miscellaneous materials necessary for the proper hanging and supporting of piping systems. Portions of this Section may not be required in this project. See drawings and each specific system description section of Division 22 for specific sizes; materials and installation methods pertaining to this project.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. Hangers and supports shall comply with ANSI/Manufacturer's Standardization Society (MSS) SP-58, SP-69 and SP-89. Terminology used in this section is defined in MSS SP-90.

1.1 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with these specifications, pipe hanger and support systems shall be as manufactured by one of the following:

1. ANVIL
2. ELCEN
3. ERICO, Inc.
4. Fee and Mason
5. Grinnell
6. Hydra-Zorb Company
7. MetraFlex
8. PHD Manufacturing Inc.
9. Pipe Shields

2.2 PIPE HANGERS AND SUPPORTS

A. All hangers, brackets, clamps, etc., shall be of standard weight galvanized steel. Perforated strap hangers shall not be used in any work. Each hanger is to be sized to include pipe insulation.

B. All model numbers referenced within this specification are as manufactured by Erico.

C. When two or more pipes are run parallel, they may be supported on Unistrut type trapeze hangers. Insulation on insulated pipe shall be continuous at trapeze hangers. At each trapeze hanger provide a minimum 12" long insulation protection shield, Model 126 or 127 with 180° calcium silicate shield insert; thickness shall match thickness of insulation.

D. In general, support individual horizontal piping as follows:

Table 22 12 20.1

Pipe Description	Pipe Size	Hanger Description
Uninsulated steel and plastic piping	2” and smaller	Model 100 heavy duty galvanized steel swivel loop hanger
	2-1/2” and larger	Model 400 carbon steel clevis hanger.
Uninsulated copper piping	2” and smaller	Model 101 copper plated steel swivel loop hanger
	2-1/2” and larger	Model 402 copper plated steel clevis hanger
Insulated piping (hot or cold)	2" and smaller	Model 403 carbon steel clevis hanger for insulated pipe (thickness to match adjacent pipe insulation). Insulation vapor barrier to be continuous at each hanger
Insulated hot piping	2-1/2” and larger	Model 610 steel one rod roller hanger with carbon steel pipe insulation protection saddle. Saddle size shall match adjacent piping insulation thickness.
Insulated cold piping	2-1/2” and larger	Model 403 carbon steel clevis hanger for insulated pipe with insulation protection shield spot welded in place. Install with 180° hard block calcium silicate insert with foil faced back (thickness to match adjacent pipe insulation). Insulation vapor barrier to be continuous at each hanger.

E. Support all pipe hangers from all-thread rod with additional lock nut. All-thread rod size shall match hanger attachment size. Attach all hangers to the structure with concrete inserts, "C" clamps, beam clamps, or ceiling flanges.

1. Hangers and supports anchored to poured concrete: Use malleable iron or steel concrete inserts attached to concrete forms.

2. Hangers or supports anchored to precast concrete: Use self-drilling expansion shields. Expansion shields may also be used where concrete inserts have been missed or additional support is required in poured concrete.

3. Attach all-thread rod 5/8" or smaller to steel with malleable iron beam clamps with carbon steel retainer strap.

4. Attach all-thread rod 3/4" or larger to steel with carbon steel center-load beam clamps with forged steel eye nut.

5. Attach all-thread rod to ceiling with malleable iron ceiling flanges, anchored to structural member above ceiling.

6. All adhesive hangers shall be approved for use with cracked concrete per the American Concrete Institute and ICC-ES standard AC308. All mechanical hangers shall be approved for use with cracked concrete per the American Concrete Institute and ICC-ES standard AC193.

F. Where piping is supported from below, support on carbon steel pipe saddle supports. Where piping is insulated, furnish with protection shields, insulation inserts and protection saddles similar to those used with pipe hangers. Support 2-1/2" or larger hot piping on roller supports.

G. In supporting cold piping systems, hanger installation shall permit the installation of a continuous insulation vapor barrier.

H. All insulated vertical or horizontal piping supported from walls shall have continuous insulation at all support clamps. At each support clamp provide a 360 degree thermoplastic elastomer cushion insert or calcium silicate shield insert; thickness shall match thickness of insulation. Provide continuous vapor barrier.

I. All non-insulated vertical or horizontal piping supported from walls shall have a 360 degree thermoplastic elastomer cushion insert at each support clamp.

2.3 VERTICAL PIPE FRICTION CLAMPS

A. In general support all vertical piping with friction type riser clamps - Model 450 or 451 for uninsulated pipes or Model 452 for insulated pipes.

1. Steel or cast iron piping – carbon steel.

2. Copper piping – copper plated carbon steel.

2.4 MANUFACTURED UNITS

A. Hangers and support components shall be factory fabricated of materials, design and manufacturer complying with MSS SP-58.

1. Components shall have galvanized coatings where installed for piping and equipment that will not have field-applied finish.

B. Thermal Hanger Shield Inserts: 100 psi average compressive strength, waterproofed calcium silicate, encased with a sheet metal shield. Insert and shield shall cover a 180 degree circumference of the pie and shall be of length indicated by manufacturer for pipe size and thickness of insulation.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide all hangers, supports and clamps to properly support and retain piping, to control expansion, contraction and drainage and to prevent sway and vibration.

B. Examine areas and conditions where the hangers, supports, clamps and inserts are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the installer. Proceed only after the required building structural work has been completed in the area where the piping is to be installed.

C. The use of explosive force hammer actuated, booster assist or similar anchoring device is not permitted without prior approval from the Architect.

D. Provide all supplementary angles, channels, rails and plates required for support of piping. Attach to building structural members by welding, bolting or anchoring. Ceiling flanges shall be secured to the structural member above ceiling - anchoring ceiling flanges to drywall "only" is not acceptable.

E. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze hangers. Construct of a channel or unistrut with adjustable all-thread rods. Hanger spacing shall be determined by the smallest pipe supported. Provide all insulation protection shields, insulation inserts and protection saddles similar to those used with individual hangers. In supporting cold piping systems, trapeze hanger installation shall permit the installation of a continuous insulation vapor barrier.

F. Install hangers and supports to allow for controlled movement of the piping system, to permit movement between pipe anchors and to facilitate the action of expansion joints and bends.

G. Install hangers and supports to provide indicated pipe slopes.

H. Support all fire protection piping independently of other piping, per NFPA requirements.

I. Do not support piping from another pipe or from ductwork or equipment. Do not support ceiling framing or lighting from piping.

J. Adjust hangers and supports to equally distribute the load between all supporting members.

K. Support all vertical copper piping with riser clamps at intervals not over 10 feet. Support all vertical steel piping at intervals not over 15 feet.

L. Support all piping independently from equipment and isolate to prevent transmission of vibration of equipment to piping. No piping is to impose a load upon the equipment to which it is connected.

M. If any fire proofing materials are disturbed while attaching piping hangers and supports, patch/repair those areas with the same fire proofing materials and of the same thickness as adjacent areas.

END OF SECTION 22 12 20

SECTION 22 12 30
THERMOMETERS AND GAUGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies thermometers and gauges common to more than one section of Division 22 and includes materials, specialties, and basic installation instructions. Portions of this Section may not be required in this project. See drawings and each specific system description section of Division 22 for specific sizes; materials and installation methods pertaining to this project.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. UL Compliance:

1. Comply with applicable UL standards pertaining to thermometers and gauges.

2. Comply with NSF/ANSI 372 for use in potable water applications

B. ASME and ISA Compliance: Comply with applicable portions of ASME and Instrument Society of America (ISA) standards pertaining to construction and installation of thermometers and gauges.

1.1 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 THERMOMETERS

A. Acceptable manufacturers: Subject to compliance with requirements, provide thermometers as manufactured by one of the following:

1. Trerice Co.

2. Weiss Instruments, Inc.

3. Marshalltown Instruments, Inc.

B. Provide thermometers in a die cast aluminum case and adjustable joint with baked enamel finish, 9" long, with spring secured heavy glass front and locking device capable of 180° vertical and 360° horizontal adjustment. Non-toxic red safety liquid filled-magnifying lens, red reading tube, silicone shock-mounted, one percent accuracy. Satin faced non-reflective aluminum scale with permanently etched markings. Copper-plated steel stem, separable socket well, length to suit installation. Thermometers shall be suitable for the service of the piping system where installed.

C. Thermometer wells shall be brass in copper pipe and stainless steel in steel pipe, pressure rated to match piping system design pressure. Where piping is to be insulated, provide with extension.

D. Scale temperature ranges as follows:

1. Hot water: 30° - 240°F
2. Cold water: 0° - 100°F

2.2 PRESSURE GAUGES (WATER/STEAM)

A. Acceptable manufacturers: Subject to compliance with requirements, provide pressure gauges as manufactured by one of the following:

1. H.O. Trerice Co.
2. Weiss Instruments, Inc.
3. Marshalltown Instruments, Inc.
4. Dwyer Instruments, Inc
5. Pasco Specialty & Mfg, Inc.
6. Weksler, a brand of Ashcroft –Nagano Keiki Holdings, Inc.

B. General use, ANSI B40.1 grade A, with accuracy of plus or minus 1%. Phosphor bronze bourdon-tube and brass socket for 1/4" NPT bottom connection. 4-1/2" diameter steel case with clear acrylic plastic lense. Aluminum dial with white background and permanently etched black markings. Aluminum pointer with black finish.

C. Provide gauges with 1/4" NPT brass bushing snubbers with corrosion resistant porous metal disc suitable for the service and pressure rating of the piping system where installed. Between gauge and tee in piping system, provide 1/4" bronze body, threaded ball valve suitable for the service and pressure rating of the piping system where installed.

D. Where pressure gauge is installed in a steam system provide 1/4" NPT straight type brass steam gauge syphon.

E. Range: Conform to the following:

Domestic hot and cold water: 30 to 150 psig.

2.3 PRESSURE GAUGES (NATURAL GAS)

A. Acceptable manufacturers: Subject to compliance with requirements, provide pressure gauges as manufactured by one of the following:

1. H.O. Trerice Co.
2. Weiss Instruments, Inc.
3. Marshalltown Instruments, Inc.
4. Dwyer Instruments, Inc
5. Pasco Specialty & Mfg, Inc.
6. Weksler, a brand of Ashcroft –Nagano Keiki Holdings, Inc.

B. Natural gas pressure gauges shall conform to ANSI B40.100 , with accuracy of plus or minus 1.6%.

C. Gauges shall contain brass movement with 316L stainless steel diaphragm capsule and brass socket for 1/4" NPT bottom connection.

D. Gauges shall have a 4" diameter black finished steel case with clear polycarbonate lens, an aluminum dial with white background and permanently etched black markings and an aluminum pointer with black finish, adjustable via screw on dial face.

E. Between gauge and tee in piping system, provide a 1/4" bronze body, threaded ball valve suitable for the service and pressure rating of the piping system where installed.

F. Range: Conform to the following:

0 to 15 inches w.c. – for low pressure natural gas (less than 10 inches w.c.)

0 to 30 inches w.c. – for low pressure natural gas (zero to 14 inches w.c.)

0 to 3 psi – for low pressure natural gas (zero to 2 psi)

0 to 10 psi – for intermediate pressure natural gas (zero to 5 pis)

PART 3 - EXECUTION

3.1 THERMOMETERS INSTALLATION

A. Install thermometers in vertical or tilted positions to allow reading by observer standing on the floor. Install thermometer wells in the vertical position. Fill well with oil or graphite and secure cap. Adjust faces to proper angle for best visibility.

B. Install hydronic thermometers in the following locations and elsewhere as indicated

1. At outlet of each domestic water heater.
2. At inlet and outlet of each main thermostatic mixing valve.
3. At outlet of each domestic hot water recirculating pump.

3.2 PRESSURE GAUGES INSTALLATION

A. Install pressure gauges located in the piping at the most readable location for an observer standing on the floor. Install with shut off valve and snubber. For steam systems install with gauge siphon, Pressure gauges shall be installed as close as possible to the equipment or apparatus to indicate pressure changes across equipment or apparatus only. Adjust faces to proper angle for best visibility.

B. Install hydronic pressure gauges in the following locations and elsewhere as indicated.

1. At outlet of each domestic water service backflow preventer.
2. At inlet and outlet of each domestic hot water circulating pump.
3. At inlet and outlet of domestic water booster pumps.
4. At outlet of each domestic hot water heater with input greater than 200 MBH.

C. Install natural gas pressure gauges in the following locations and elsewhere as indicated.

1. At gas inlet of each domestic hot water heater.
2. At gas inlet of each domestic hot water boiler.
3. At inlet and outlet of each gas pressure regulator.

3.3 ADJUSTING AND CLEANING

A. Adjusting: Adjust faces of thermometers and gauges to proper angle for best visibility.

B. Cleaning: Clean windows of thermometers and gauges and factory-finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touch-up paint.

C. Connections: Piping installation requirements are specified in other sections of Division 22. The drawings indicate the general arrangement of piping, fittings and specialties. The following are specific connection requirements:

1. Install thermometers and gauges piping adjacent to equipment to allow servicing and maintaining of equipment.

END OF SECTION 22 12 30

SECTION 22 12 40
FLEXIBLE PIPE CONNECTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies flexible pipe connectors common to more than one section of Division 22 and includes materials, specialties, and basic installation instructions. Portions of this Section may not be required in this project. See drawings and each specific system description section of Division 22 for specific sizes; materials and installation methods pertaining to this project.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 QUALITY ASSURANCE

A. Provide flexible pipe connectors of same type by same manufacturer.

1.4 CODES AND STANDARDS

A. ASME Compliance: Manufacture and install flexible pipe connectors in accordance with ASME B31.9 "Building Services Piping."

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide flexible pipe connectors as manufactured by one of the following:

1. Hyspan Precision Products, Inc.
2. Keflex, Inc.
3. Mason Industries
4. Metraflex

2.2 WOVEN HOSE FLEXIBLE CONNECTORS

A. Stainless steel hose covered with stainless steel wire braid with MPT nipples rated at minimum 600 psig working at 250°F.

B. Class flanges rated at 125 psig and 240°F maximum temperature.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which flexible pipe connectors are to be installed.

B. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION

A. Install where indicated on the drawings and according to manufacturer's recommendations. Install in the following locations, even if not specifically indicated on the drawings:

1. Install woven hose flexible connectors on the hot water piping connections to each inline recirculating water pump.

3.3 FIELD QUALITY CONTROL

A. Upon completion of installation of flexible pipe connectors and after units are water pressurized, test units to demonstrate capability and compliance with requirements.

B. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new unit and proceed with retesting.

END OF SECTION 22 12 40

SECTION 22 12 50
WATER HAMMER ARRESTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies water hammer arrestors and includes materials, testing and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. All plumbing systems shall comply with the Local Plumbing Code and all requirements of the local authority having jurisdiction.

B. Plumbing systems shall comply with ANSI, ASPE, ASSE ASTM, CSA, NSF, and AWWA requirements.

C. Water hammer arrestors (shock stops) shall comply with ANSI/ASME A112.26.1M and ASSE 1010.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide water hammer arrestors as manufactured by one of the following:

1. Zurn Industries, Inc.
2. Josam
3. J.R. Smith
4. Wade

2.2 CONSTRUCTION

A. Water hammer arrestors shall be bellows type. Casing and bellows shall be constructed of stainless steel.

2.3 PERFORMANCE

A. Shock stops shall have sufficient displacement volume to dissipate the calculated kinetic energy generated in the piping system.

B. Shock stops shall be tested and certified in accordance with the Plumbing Drainage Institute "Standard PDI WH-201".

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide a water hammer arrestor at each solenoid valve, flush valve, washer machine water feed, or piece of equipment that has a quick-closing type valve or as indicated on the drawings. Water hammer arrestors for down-feed risers to be installed at top of riser.

B. Size water hammer arrestor according to fixture unit count.

C. Provide water hammer arrestor at each group of water closets and urinals as indicated.

3.2 CONNECTIONS

A. Water Hammer Arrestors

1. Coordinate installation location with architectural wall and ceiling design. Where concealed within a plumbing chase or above a drywall ceiling, the General Contractor shall provide an access door of sufficient size so as to facilitate servicing and replacement of the device. Access doors shall match any ratings of the wall or ceiling where installed.

2. Install water hammer arresters in water piping with a shutoff isolation valve.

3.3 INSPECTION, TESTING AND DISINFECTION

A. Water hammer arrestors shall be subjected to the same pressure test specified for domestic water piping. Installer shall verify arrestors are capable of withstanding the specified pressure and duration of the test.

B. Water hammer arrestors shall be subjected to the same chlorination/sanitation procedure specified for domestic water piping. Installer shall verify arrestors are capable of withstanding the specified procedure and any chemicals utilized to perform such procedures.

3.4 FIELD QUALITY CONTROL

A. Upon completion of installation of water hammer arrestors and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new unit and proceed with retesting.

END OF SECTION 22 12 50

SECTION 22 12 60
CLEANOUTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies cleanout materials and installation methods for gravity drained sanitary and storm water piping systems and includes fittings, joining methods and basic installation instructions.

B. Portions of this Section may not be required in this project. See drawings for specific requirements and cleanout sizes pertaining to this project.

C. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 SPECIFIC CODES AND STANDARDS

A. Furnish and install cleanouts in accordance with regulations required by local the local authority having jurisdiction.

1.4 DELIVERY, STORAGE AND HANDLING

A. Storage: Elevate above grade and do not exceed structural capacity of the floor or structure.

B. Provide factory-applied plastic shrink-wrap on each cleanout. Maintain through shipping, storage, and handling to prevent damage and prevent entrance of dirt, debris and moisture.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 GENERAL

A. Cleanouts shall be constructed of materials as herein specified, and joined to associated piping system with joining methods as specified in other sections.

2.2 EXPOSED METAL CLEANOUTS

A. Manufacturers: Subject to compliance with requirements, provide products as manufactured by one of the following:

1. Josam Company; Josam Div.
2. MIFAB, Inc.
3. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.

6. Zurn Plumbing Products Group; Specification Drainage Operation.
7. Josam Company; Blucher-Josam Div.

B. Standard: ASME A112.36.2M for cast iron for cleanout test tee.

C. Size: Same as connected drainage piping.

D. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.

E. Closure: Countersunk cast-iron plug.

F. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

G. Closure: Stainless-steel plug seal.

2.3 METAL FLOOR CLEANOUTS

A. Manufacturers: Subject to compliance with requirements, provide products as manufactured by one of the following:

1. Josam Company; Josam Div.
2. Oatey.
3. Sioux Chief Manufacturing Company, Inc.
4. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
5. Tyler Pipe; Wade Div.
6. Watts Drainage Products Inc.
7. Zurn Plumbing Products Group; Light Commercial Operation.
8. Zurn Plumbing Products Group; Specification Drainage Operation.
9. Josam Company; Josam Div.
10. Kusel Equipment Co.
11. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
12. Josam Company; Blucher-Josam Div.

B. Standard: ASME A112.36.2M heavy-duty, adjustable housing cleanout.

C. Size: Same as connected branch (see Part 3 – Execution).

D. Type: Heavy-duty, adjustable housing.

E. Body or Ferrule: Cast iron.

F. Clamping Device: Not required.

G. Outlet Connection: Threaded.

H. Closure: Cast-iron plug.

I. Adjustable Housing Material: Cast iron with threads.

J. Frame and Cover Material and Finish: Rough bronze.

K. Frame and Cover Shape: Round.

L. Top Loading Classification: Medium Duty (unless scheduled differently).

M. Riser: ASTM A 74, Extra-Heavy Service class, cast-iron drainage pipe fitting and riser to cleanout.

N. Standard: ASME A112.3.1.

O. Size: Same as connected branch.

P. Housing: Stainless steel.

Q. Closure: Stainless steel with seal.

R. Riser: Stainless-steel drainage pipe fitting to cleanout.

2.4 CAST-IRON WALL CLEANOUTS

A. Manufacturers: Subject to compliance with requirements, provide products as manufactured by one of the following:

1. Josam Company; Josam Div.
2. MIFAB, Inc.
3. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Standard: ASME A112.36.2M. Include wall access.

C. Size: Same as connected drainage piping (see Part 3 – Execution).

D. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.

E. Closure: Countersunk plug.

F. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

G. Wall Access: Round, flat, chrome-plated brass cover plate with screw (unless scheduled differently).

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Installation shall conform to all requirements in “Common Piping Requirements” section of these Division 22 Specifications.

B. Where change of direction in the piping system is greater than 45°, install wye fitting with required bends and clean-out.

C. Provide clean-outs at the base of all stacks and vertical storm leaders; at changes of direction in horizontal drain piping greater than 45° and as shown on the drawings. Provide clean-outs in horizontal straight runs of piping at intervals not over 50'. Install clean-outs wherever storm sewers and sanitary sewers exit the building.

D. Clean-outs in concealed piping or piping below the floor shall be extended through and terminate flush with the finished floor above.

E. Clean-outs shall be the same size as the pipe to which they are connected up to 4". Pipes larger than 4" shall have a 6" clean-out.

F. Install all clean outs with required clearance for rodding.

3.2 CLEANING

A. After piping installation is complete, thoroughly flush the piping system with a material/detergent that is not injurious to the pipe, to remove all pipe dope, oils, welding slag, scale and other extraneous material.

3.3 TESTING

A. All plumbing piping systems specified herein shall be hydrostatically tested per the "Piping Systems Flushing and Testing" section of Division 22 Specifications.

END OF SECTION 22 12 60

SECTION 22 13 10
DOMESTIC WATER VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies valves used in plumbing piping systems and includes general descriptions and installation methods.

1.3 DEFINITIONS

A. ANSI - American National Standards Institute

B. ASME - American Society of Mechanical Engineers

C. CWP - Cold Working Pressure

D. EPDM - Ethylene Propylene Diene Monomer

E. PSI - Pounds per square inch

F. PSID - Pounds per square inch differential

G. PSIG - Pounds per square inch gage

H. P/T - Pressure and Temperature

1.4 QUALITY ASSURANCE

A. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

2. ASME B31.9 for building services piping valves.

B. NSF Compliance:

1. All domestic water valves shall comply with NSF 61 and NSF 372 for low lead content.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.

2. Protect threads, flange faces, grooves, and weld ends.

3. Set ball, plug, and balance valves open to minimize exposure of functional surfaces.

4. Set butterfly valves closed or slightly open.

5. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.

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

C. Use a sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

1.6 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 GENERAL VALVE REQUIREMENTS

A. Where possible provide all valves of the same manufacturer. All valves shall have the manufacturer's name (or trademark) and pressure rating clearly marked on the valve body.

B. Provide factory-fabricated valves of types and temperature/pressure ratings as indicated, suitable for the service in which the valve is installed.

C. Unless otherwise indicated, provide valves of same size as the pipe in which it is installed.

D. Where valves are to be insulated, provide an extended stem arranged to receive insulation.

2.2 SHUT-OFF VALVES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide shut-off valves as manufactured by one of the following:

1. 2" and smaller: Bronze body, two piece, full port ball valves with lever handle, Teflon seats, chrome plated brass ball, brass stem and threaded ends, 600 psi CWP.

a. Apollo

b. Hammond

c. Jomar Valve

d. Milwaukee

e. Nibco

f. Stockham

g. Watts

2. 2-1/2" and larger (in welded systems): Cast iron body, lug type butterfly valves with stainless steel stem, aluminum bronze disc and EPDM liner, 200 psi working pressure. Operators: Provide lever handles for sizes 2-1/2" to 6"; provide gear operators for sizes 8" and larger; provide chain operators for sizes 8" and larger installed 10'-0" or more above the finished floor in mechanical rooms (chain shall provide operation at 6'-0" above finished floor).

a. Apollo

b. Hammond

c. Metraflex

d. Milwaukee

e. Nexus

f. Nibco

g. Stockham

2.3 HORIZONTAL SWING CHECK VALVES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide horizontal swing check valves as manufactured by one of the following:

1. 2" and smaller: Bronze body, bronze disc, horizontal swing type with threaded ends, 200 psi CWP.

a. Crane

b. Hammond

c. Jenkins

d. Milwaukee

e. Nibco

f. Stockham

2.4 MANUAL BALANCING VALVES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide manual balancing valves as manufactured by one of the following:

1. 2" and smaller: Bronze body, combination venturi and ball valve with lever handle, memory stop, two P/T ports, inlet union connection and threaded ends, 400 psi at 250°F.

a. Bell & Gossett

b. Flow Design Inc.

c. Griswold

d. Nexus

e. Hydronic Components

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

F. All valves shall be installed in accessible locations in a position to allow full stem movement. On horizontal overhead runs, install valves with stems in the horizontal position. On horizontal runs near the floor, install valves with stem in the vertical or 45 degree angle position.

3.2 SHUT-OFF VALVE INSTALLATION

A. Shut-off valves shall be provided at all branch connections to piping mains, at bases of all risers, at each piece of equipment, in piping mains to sectionalize the systems and elsewhere as indicated. Valve locations shall permit proper and safe operation of all systems and facilitate maintenance and/or removal of all equipment and apparatus.

B. In no case shall valves be installed with stems below the horizontal position.

C. Valves shall be installed full line size. Piping reductions shall be made only at the inlet or outlet of pressure reducing valves, regulating valves, or equipment.

3.3 SWING CHECK VALVE INSTALLATION

A. Install swing check valves in vertical position with flow upward or in the horizontal position with hinge pin horizontally perpendicular to the centerline of the pipe. Install for proper direction of flow.

B. If faucets or hose bibbs with hose thread outlets do not have integral check valves, provide check valves in hot and cold water piping serving this equipment.

C. If mixing valves do not have integral check valves, provide check valves in hot and cold water piping serving this equipment.

3.4 BALANCE VALVE INSTALLATION

A. Install balancing valves with at least the minimum straight length of pipe, upstream and downstream of the valve, required by the manufacturer for maximum accuracy.

B. The Division 23 balancing Contractor shall document flows for balance valves.

3.5 ADJUSTING

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

END OF SECTION 22 13 10

SECTION 22 13 11
DOMESTIC WATER MIXING VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies mixing valves used in domestic water piping systems and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against contamination.

2. Protect thread ends.

B. Use the following precautions during storage:

1. Maintain valve end protection.

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

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Where possible provide all valves of the same manufacturer. All valves shall have the manufacturer's name (or trademark) and pressure rating clearly marked on the valve body.

B. Provide factory-fabricated valves of types and temperature/pressure ratings as indicated, suitable for the service in which the valve is installed.

C. Unless otherwise indicated, provide valves of same size as the pipe in which it is installed.

2.2 INDIVIDUAL-FIXTURE, WATER TEMPERING VALVES

A. Manufacturers: Subject to compliance with requirements, provide tempering valves as manufactured by one of the following:

1. Apollo Valves

2. Armstrong International, Inc.

3. Conbraco Industries, Inc.

4. Lawler Manufacturing Company, Inc.
5. Leonard Valve Company
6. Powers; a Watts Industries Co.
7. Watts Industries, Inc.; Water Products Div.
8. Zurn Plumbing Products Group; Wilkins Div.

B. Provide below deck thermostatic water mixing valve for use with a single electronic faucet.

C. Thermostatic water mixing valve shall have the following features:

1. Designed for under-the-lavatory applications where the outlet temperature of hot water must be controlled for safe, economic use.
2. Designed to quickly sense and compensate for temperature fluctuations induced by water temperature and pressure changes in the supply line.
3. Water temperature adjustment stem with lock nut to prevent tampering.
4. Inlet supply lines to be installed with check valves. Integral check valves alone not acceptable.
5. Standards: Complies with performance standards ASSE 1070 and CSA B125 for thermostatically controlled water tempering valve.
6. Pressure Rating: 125 psig minimum.
7. Body: Lead free bronze body with corrosion-resistant interior components.
8. Temperature Control: Adjustable – 80-120°F range.
9. Inlets and Outlet: Threaded or 3/8" compression connections.
10. Finish: Rough or chrome-plated bronze.
11. Tempered-Water Setting: **110 deg F**.
12. Minimum Activation Flow: **0.25 gpm**.
13. Maximum 5 psi pressure drop @ 1.5 gpm.

2.3 PRIMARY THERMOSTATIC MIXING VALVES (FOR MULTIPLE FIXTURES)

A. Acceptable Manufacturers: Subject to compliance with requirements, provide mixing valves as manufactured by one of the following:

1. Apollo Valves
2. Armstrong International, Inc.
3. Conbraco Industries, Inc.
4. Lawler Manufacturing Company, Inc.
5. Leonard Valve Company
6. Powers; a Watts Industries Co.
7. Watts Industries, Inc.; Water Products Div.
8. Zurn Plumbing Products Group; Wilkins Div.

B. Standard: ASSE 1017 and 1070.

C. Pressure Rating: 125 psig.

D. Material: Lead free bronze body with corrosion-resistant interior components.

E. Connections: Threaded [**Union**] inlet and outlet.

F. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle. Integral check valves alone not acceptable.

G. Valve Pressure Rating: 125 psig minimum.

H. Tempered-Water Setting: **110 deg F**

I. Maximum 5-psig Pressure Drop: @ 3.5 gpm

J. Minimum activation flow 0.35 gpm.

K. Cabinet (when applicable): Factory-fabricated, stainless steel, for [**recessed**] [**surface**] mounting and with hinged, stainless-steel door.

2.4 MASTER THERMOSTATIC WATER MIXING VALVE ASSEMBLIES (MECHANICAL)

A. Manufacturers: Subject to compliance with requirements, provide mixing valves as manufactured by one of the following:

1. Apollo Valves
2. Armstrong International, Inc.
3. Conbraco Industries, Inc.
4. Lawler Manufacturing Company, Inc.
5. Leonard Valve Company
6. Powers; a Watts Industries Co.
7. Watts Industries, Inc.; Water Products Div.
8. Zurn Plumbing Products Group; Wilkins Div.
9. Description: Provide factory-fabricated, [**cabinet-type**] [**exposed-mounting**], thermostatically controlled, water-mixing-valve assemblies in parallel arrangement. Thermostatic water mixing valves shall include copper encapsulated paraffin-based thermostat, locking temperature regulator handle, integral hot and cold supply checkstops, integral wall support, and internal parts of brass, bronze, and stainless steel construction. Finish shall be rough bronze.
10. Thermostatic Mixing Valves shall comply with ASSE 1017. Include check stops on hot- and cold-water inlets and shutoff valve on outlet. Integral check valves alone not acceptable.
11. Water Regulator(s) shall comply with ASSE 1003. Include pressure gage on inlet and outlet.
12. Component Pressure Rating shall be 125 psig minimum.
13. Cabinet (when applicable): Factory-fabricated, stainless steel, for [**recessed**] [**surface**] mounting and with hinged, stainless-steel door.
14. Tempered-Water Setting: **120 deg F**
15. Unit Minimum ActicationTempered-Water Design Flow Rate: **5 gpm**
16. Mixing Valves shall be ASSE Listed and 3rd Party certified as Lead Free.

2.5 MASTER THERMOSTATIC WATER MIXING VALVE ASSEMBLIES (DIGITAL)

A. Manufacturers:

1. Subject to compliance with requirements, provide mixing valves as manufactured by one of the following:

a. Armstrong

b. Leonard Valve Co.

c. Power; a Watts Industries Co.

B. Description:

1. Provide factory fabricated, exposed-mounting, electronically controlled, water-mixing-valve assemblies as indicated on the drawings. Electronic mixing valves shall be utilized in continuously pumped systems.

2. Stainless steel valve construction with polymer electronics enclosure.

3. Comply with ASSE 1017, CSA B125 and shall be CE Certified.

4. Furnish each mixing valve with integral check stops on hot-and cold-water inlets and shutoff valve on tempered water outlet.

5. Pressure Rating shall be 125 psig minimum.

6. Power shall be 100-240V AC.

7. Mixing Valves shall be ASSE Listed and 3rd Party certified as Lead Free.

C. Operations

1. Tempered-Water Setting: Per drawings

2. Unit Minimum Tempered-Water Design Flow Rate: 5 gpm

3. Maximum inlet water temperature shall be 185 def F.

4. Furnish with digital controller with integral display. Display shall be capable of indicating:

a. Set-point (deg F)

b. Inlet hot water temperature (deg F)

c. Error Codes

d. Alarm Condition

5. Furnish controller with serial communication connection capable of integrating to the building automation system via the following protocols:

a. BACnet MS/TP

b. Modbus

c. Lon Works

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness and freedom from foreign matter. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

3.2 INSTALLATION

A. Install per manufacturer's installation requirements

B. Horizontal check valves shall be provided at all cold water and hot water connections to mop basins, service sinks, and all mixing/tempering valves.

C. Provide shutoff valve on cold water and hot water inlets of each mixing valve. Locate shutoff valves in ceiling space or another accessible location.

3.3 ADJUSTMENT

A. Once the mixing valve is installed, adjust hot and cold water inlets to achieve scheduled outlet water temperature.

END OF SECTION 22 13 11

SECTION 22 13 20
NATURAL GAS VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies piping and valves for natural gas systems installed inside or outside above grade and includes materials, testing and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. All natural gas systems shall comply with the latest "International Fuel Gas Code", and local utility requirements.

B. Natural gas valves shall comply with ASME B16.44 up to 5 psig.

C. Natural gas valves shall comply with ANSI Z21.15 and ASME B16.33 up to 125 psig.

D. Natural gas valves shall be tested and listed in accordance with Underwriters Laboratories UL 842. The UL mark shall be on the valves.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 SHUT-OFF VALVES

A. Acceptable Manufacturers

1. Manufacturer: Subject to compliance with these specifications, natural gas valves shall be as manufactured by one of the following:

a. Valves 2" smaller:

1). Apollo, Conbraco Industries

2). Keystone

3). Milwaukee

4). Nibco

b. Valves 2½" and larger:

1). Dezurik

2). Homestead

3). Key Port

4). Keystone

5). Nordstrom. Flowserve Corp.

6). Resun, R+M Energy Systems

B. Valves 2" and smaller shall be forged brass or bronze body, full port ball valves with lever handle, PTFE seats, chrome plated brass ball and threaded ends, 600 psi CWP, with 5 psig pressure limit.

C. Valves 2-1/2" and larger shall be 175# WOG, cast iron, flanged body pattern lubricated plug type. Valves shall be UL listed for gas service. Provide valves with a removable wrench to match operator square head size. Wrenches shall be locked in place with a set screw. One wrench shall be suppled for every four valves. Valves requiring manual lubricant shall be provided with grease gun, 12" hose, coupler, and one-year's supply of sealant.

PART 3 - EXECUTION

3.1 GENERAL

A. Install valves in all locations as shown on the drawings

B. Install valves at all connections made to all equipment, whether indicated on the drawings or not. Provide a line-size shut-off valve, union and tee with full sized dirt leg (sediment trap) at all equipment connections. Lubricate all valves before putting the valves into service. Reduce pipe at equipment – downstream of valve.

C. Valves shall NOT be installed in portions of piping systems installed in concealed locations (i.e., inside stud walls) or within return air plenums. Valves shall be accessible.

D. All valves installed outdoors shall be painted with primer, and then two coats of rust inhibited paint-color as selected by the Architect.

E. Shut-off valves for kitchen hood fire suppression furnished by others shall be installed by the Plumbing Contractor. Interconnecting linkage or wiring shall be provided by others.

3.2 TESTING

A. All gas valves installed in gas piping systems shall be required to withstand the same inspections and testing as the piping system.

END OF SECTION 22 13 20

SECTION 22 13 21
NATURAL GAS PRESSURE REGULATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies pressure regulators for natural gas systems installed inside or outside above grade, and includes materials, testing and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. All natural gas systems shall comply with the latest "International Fuel Gas Code" and local utility requirements.

B. Gas regulators shall be ANSI Z21.18 certified.

1.1 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide gas pressure regulators as manufactured by one of the following:

1. Actaris
2. Itron
3. Maxitrol
4. Schumberger
5. Sprague
6. Norgas

2.2 OPERATION

A. Regulators shall be capable of regulating gas line pressure from inlet value to outlet value as scheduled on drawings.

B. Regulators shall, at a minimum, be capable of passing the scheduled required capacity of gas at the scheduled maximum pressure drop.

C. Regulators shall be protected from over-pressurization with an integral pressure relief mechanism.

D. Regulators shall be capable of multi-poise mounting.

E. Regulators shall provide positive dead-end lock up.

2.3 CONSTRUCTION

A. Regulator body shall be constructed of high tensile strength cast iron.

B. Orifice shall be constructed of brass.

C. Regulator Seat shall be constructed of Buna-N or silicone (for temperatures below -20 °F).

D. Diaphragm shall be constructed of Buna-N and nylon.

E. Housing shall be die cast aluminum.

2.4 CONNECTIONS

A. Furnish with flanged inlet and discharge pipe connections, of sizes as indicated on drawings.

B. If not indicated, provide both inlet and discharge sizes shall be equal to the downstream pipe size.

2.5 WARRANTY

A. Standard one (1) year manufacturer's warranty.

B. Warranty shall commence upon project turn over to the owner.

PART 3 - EXECUTION

3.1 GENERAL

A. Install gas pressure regulators as shown on the drawings in accordance with manufacturer's requirement.

B. Gas pressure regulators shall not be used as grounding electrodes.

C. Where regulators are installed indoors, pipe regulator excess pressure vented directly to the outdoors with a dedicated pipe. Pipe shall be full discharge connection size. Pipe shall not be combined inside the building with any other vent piping.

D. Connections to the piping system shall be made to meet the standards required for pipe fittings and joints, as specified in the piping specification section. Fasteners for flanged joints shall be tightened per manufacturer's recommendations.

E. Install regulators properly so flow through them is oriented in the direction recommended by the manufacturer.

F. All specialties installed outdoors shall be painted with primer, and then two coats of rust inhibited paint-color as selected by the Architect.

G. All regulators shall be separately vented full size to the exterior, with a turndown elbow and insect screen. Vent outlet shall not terminate within 20 feet of a combustion or fresh air intake.

3.2 INSPECTION, TESTING, AND PURGING

A. All gas specialties installed in gas piping systems shall be required to withstand the same inspections and testing as the piping system.

END OF SECTION 22 13 21

SECTION 22 13 51
LABORATORY VACUUM VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

C. See other Division 22 Specifications for laboratory vacuum piping, outlets, testing and verification requirements.

1.2 SCOPE

A. This Section specifies laboratory vacuum system service valves and accessories and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. Installation shall comply with the OBC - Pressure Piping Systems Code including obtaining a permit and inspection as required.

1.4 QUALITY ASSURANCE

A. Installing contractor shall have at least 3 years successful installation experience on projects with gas and vacuum systems work similar to that required for this project.

B. All installers must be certified by a qualified certification center. Installation and certification shall comply with ANSI/IAMPO/ASSE Series 6000.

C. Testing and verification of all medical gas systems shall be conducted by an independent agency; this contractor shall bear all costs required for testing and certification.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Aluminum Alloy Tubing Systems: Subject to compliance with requirements, provide laboratory vacuum valves as manufactured by one of the following:

1. Champion

2. Others, as approved by Engineer.

B. Brazed Copper Piping Systems: Subject to compliance with requirements, provide shut-off valves as manufactured by one of the following:

1. Apollo

2. Hammond

3. Jomar Valve
4. Milwaukee
5. Nibco
6. Stockham
7. Watts

2.2 VALVES

A. For use in aluminum alloy twist-lock systems:

1. Utilize quarter turn ball valves, approved by piping system manufacturer for use in the their twist-lock system.

B. For use in brazed copper systems:

1. Bronze body, two piece, full port ball valves with lever handle, Teflon seats, chrome plated brass ball, brass stem and threaded ends, 600 psi CWP.
2. Furnish and install only valves with factory installed type K copper tubing extensions.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Install valves in accordance with the drawings, specifications and manufacturer's instructions.

B. Install piping valves as indicated, except where deviations to layout are approved by the design engineer on coordination drawings.

END OF SECTION 22 13 51

SECTION 22 13 80
COMPRESSED AIR VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies valves used in compressed air piping systems and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 DEFINITIONS

A. ANSI - American National Standards Institute

B. ASME - American Society of Mechanical Engineers

C. CWP - Cold Working Pressure

D. EPDM - Ethylene Propylene Diene Monomer

E. PSI - Pounds per square inch

F. PSID - Pounds per square inch differential

G. PSIG - Pounds per square inch gage

H. P/T - Pressure and Temperature

1.4 QUALITY ASSURANCE

A. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

2. ASME B31.9 for building services piping valves.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.

2. Protect threads, flange faces, grooves, and weld ends.

3. Set ball, plug, and balance valves open to minimize exposure of functional surfaces.

4. Set butterfly valves closed or slightly open.

5. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.

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

C. Use a sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

1.6 SUBMITTALS

1. Shop Drawings: Provide Shop Drawings, per requirements of Sections 22 01 10 and 22 01 20.

A. Operation and Maintenance (O&M) Manuals" Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 GENERAL VALVE REQUIREMENTS

A. Where possible provide all valves of the same manufacturer. All valves shall have the manufacturer's name (or trademark) and pressure rating clearly marked on the valve body.

B. Provide factory-fabricated valves of types and temperature/pressure ratings as indicated, suitable for the service in which the valve is installed.

C. Unless otherwise indicated, provide valves of same size as the pipe in which it is installed.

D. Where valves are to be insulated, provide an extended stem arranged to receive insulation.

2.2 SHUT-OFF VALVES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide shut-off valves as manufactured by one of the following:

1. 2" and smaller: Bronze body, two piece, full port ball valves with lever handle, Teflon seats, chrome plated brass ball, brass stem and threaded ends, 600 psi CWP.

a. Apollo

b. Hammond

c. Jomar Valve

d. Milwaukee

e. Nibco

f. Stockham

g. Watts

2. 2-1/2" and larger (in welded systems): Cast iron body, lug type butterfly valves with stainless steel stem, aluminum bronze disc and EPDM liner, 200 psi working pressure. Operators: Provide lever handles for sizes 2-1/2" to 6"; provide gear operators for sizes 8" and larger; provide chain operators for sizes 8" and larger installed 10'-0" or more above the finished floor in mechanical rooms (chain shall provide operation at 6'-0" above finished floor).

a. Apollo

b. Hammond

c. Metraflex

d. Milwaukee

e. Nexus

f. Nibco

g. Stockham

2.3 PRESSURE REGULATING VALVES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide shut-off valves as manufactured by one of the following:

1. Apollo
2. Hammond
3. Jomar Valve
4. Milwaukee
5. Nibco
6. Stockham
7. Watts

2.4 PRESSURE RELIEF VALVES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide shut-off valves as manufactured by one of the following:

1. Apollo
2. Hammond
3. Jomar Valve
4. Milwaukee
5. Nibco
6. Stockham
7. Watts

B. Valves shall consist of a bronze body (sizes 1/2 to 2 1/2 in.) with NPT threaded male inlet and threaded female outlet (drain) connections.

C. Valves shall be ASME Section VIII rated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

F. All valves shall be installed in accessible locations in a position to allow full stem movement. On horizontal overhead runs, install valves with stems in the horizontal position. On horizontal runs near the floor, install valves with stem in the vertical or 45 degree angle position.

3.2 SHUT-OFF VALVE INSTALLATION

A. Shut-off valves shall be provided at all branch connections to piping mains, at bases of all risers, at each piece of equipment, in piping mains to sectionalize the systems and elsewhere as indicated. Valve locations shall permit proper and safe operation of all systems and facilitate maintenance and/or removal of all equipment and apparatus.

B. In no case shall valves be installed with stems below the horizontal position.

C. Valves shall be installed full line size. Piping reductions shall be made only at the inlet or outlet of pressure reducing valves, regulating valves, or equipment.

3.3 PRESSURE REGULATOR INSTALLATION

A. Pressure regulating valves shall be provided where noted on the drawings and as recommended by the air compressor equipment manufacturer.

B. Valves shall be installed full line size. Piping reductions shall be made only at the inlet or outlet of pressure reducing valves, regulating valves, or equipment.

3.4 PRESSURE RELIEF VALVE INSTALLATION

A. Pressure regulating valves shall be provided where noted on the drawings and as recommended by the air compressor equipment manufacturer.

B. Valves shall be installed full line size. Piping reductions shall be made only at the inlet or outlet of pressure reducing valves, regulating valves, or equipment.

3.5 ADJUSTING

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

B. Set final discharge pressure set-point for all pressure regulating valves.

C. Set final pressure relief set-point for all pressure relief valves.

END OF SECTION 22 13 80

SECTION 22 14 10
REDUCED PRESSURE BACKFLOW PREVENTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes the materials and installation requirements for reduced pressure backflow preventers.

B. Furnish equipment, materials, labor and supervision necessary to provide and install reduced pressure backflow preventers.

1.3 CODES AND STANDARDS

A. Installation shall conform to the requirements of the local water department.

B. EPA Compliance: All reduced pressure backflow preventer assemblies shall be in full compliance with EPA requirements.

C. Plumbing systems shall comply with ASPE, ASSE and AWWA requirements.

1.1 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products as manufactured by one of the following:

1. Conbraco
2. Febco
3. Hersey
4. Watts
5. Wilkins

2.2 REDUCED PRESSURE BACKFLOW PREVENTER

A. 2" and smaller:

1. Bronze body with stainless steel internal parts.
2. Reduced pressure principle type with differential relief valve located between two positive seating check valves.
3. Assembly shall comply with the requirements of ASSE Standard 1013.
4. Furnish with full port bronze ball valves on inlet and outlet and ball type test cocks.

5. Provide with air gap drain.
6. Maximum working pressure: 175 psi.

B. 2-1/2" and larger:

1. Epoxy coated (FDA approved) ductile or cast iron body with stainless steel internal parts.
2. Reduced pressure principle type with differential relief valve located between two positive seating check valves.
3. Assembly shall comply with the requirements of ASSE Standard 1013.
4. Furnish with OS&Y gate valves (AWWA approved) on inlet and outlet and ball type test cocks.
5. Provide with air gap drain.
6. Maximum working pressure: 175 psi.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Provide pressure gauge on outlet of the assembly.

B. Install assembly per the local water department requirements.

C. Reduced pressure backflow preventers serving building equipment or systems shall be the same size as the piping.

D. Installation above a ceiling is not permitted.

E. Install assembly with a drain line (with air gap) piped to an adjacent floor drain.

F. Backflow devices must meet ASSE Standards 1013, 1015 and 1020 and shall be tested at the time of installation by a person certified by the **Ohio Department of Health**. The Plumbing Contractor shall pay for all costs associated with this test.

3.2 DELIVERY, STORAGE, HANDLING

A. Store backflow preventer on site or off site to avoid damage due to construction activity and weather.

3.3 CONNECTIONS

A. Make final cold water connection and provide necessary piping, materials, and fittings for a complete installation.

B. Air gap drain pipe size to match drain funnel connection size. Drain piping shall slope to nearest floor drain with a continuous slope, without water traps.

3.4 CLEANING

A. Remove all fixture labels and clean backflow preventer to remove construction dirt and debris.

END OF SECTION 22 14 10

SECTION 22 14 20
DUAL CHECK BACKFLOW PREVENTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes the materials and installation requirements for dual check backflow preventers.

B. Furnish equipment, materials, labor and supervision necessary to provide and install backflow preventers.

1.3 CODES AND STANDARDS

A. All plumbing systems shall comply with the Local Plumbing Code and all requirements of the local authority having jurisdiction.

B. Plumbing systems shall comply with ANSI, ASPE, ASSE ASTM, CSA, NSF, and AWWA requirements.

C. EPA Compliance: Backflow preventers shall be in full compliance with EPA requirements.

D. Dual check valves (for use with ice makers and humidifiers) shall comply with ANSI/ASSE 1024, CSA B64.6.

E. Dual check valves (for use with beverage dispensing machines and coffee makers) shall comply with ANSI/ASSE 1022.

1.1 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products as manufactured by one of the following:

1. Conbraco
2. Febco
3. Hersey
4. Josam
5. J.R. Smith
6. Nibco
7. Watts

8. Wilkins
9. Zurn

2.2 CONSTRUCTION

A. Assembly shall comply with the requirements of ANSI/ASSE Standard 1024 or ANSI/ASSE Standard 1022.

B. Cast bronze body with plastic check modules, injection molded with acetyl resin and PPO, with silicone discs and Buna 'N' seals, stainless steel springs. Check modules shall be replaceable.

C. Furnish with minimum one nut drilled union with O-ring unit seal.

D. Flow direction arrow shall be permanently affixed to valve body.

E. Maximum working pressure: 150 psi.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Install assembly per the local water department requirements. Provide shutoff isolation valve upstream of each dual check valve.

3.2 DELIVERY, STORAGE, HANDLING

A. Store backflow preventer on site or off site to avoid damage due to construction activity and weather.

3.3 CONNECTIONS

A. Make final cold water connection and provide necessary piping, materials, and fittings for a complete installation.

3.4 CLEANING

A. Remove all fixture labels and clean backflow preventer to remove construction dirt and debris.

END OF SECTION 22 14 20

SECTION 22 17 30
STRAINERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies strainers used in plumbing piping systems and includes general descriptions and installation methods.

1.3 DEFINITIONS

A. The following are definitions and abbreviations used in this section:

1. ANSI - American National Standards Institute.
2. ASME - American Society of Mechanical Engineers.
3. EPDM - Ethylene Propylene Copolymer Rubber.
4. NSF - National Sanitary Foundation
5. NPT - Nominal Pipe Thread

1.4 QUALITY ASSURANCE

A. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for dimensions and design criteria.
2. NPT threads per ANSI B1.20.1
3. Comply with NSF/ANSI 372 for use in potable water applications

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare strainers for shipping as follows:

1. Protect internal parts against contamination.
2. Protect threads.

B. Use the following precautions during storage:

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

PART 2 - PRODUCTS

2.1 GENERAL

A. Where possible provide all strainers of the same manufacturer. All strainers shall have the manufacturer's name (or trademark) and pressure rating clearly marked on the strainer body.

B. Provide factory-fabricated strainers of types and temperature/pressure ratings as indicated, suitable for the service in which the strainer is installed.

C. Unless otherwise indicated, provide strainers of same size as the pipe in which it is installed.

2.2 STRAINERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide strainers as manufactured by one of the following:

1. Apollo
2. Armstrong
3. Crane
4. Hayward
5. Mueller
6. Nibco
7. Spirax-Sarco
8. Watts

B. Strainers 2" and smaller:

1. Cast bronze body.
2. Cover, bonze.
3. Gaskets, EPDM (non asbestos).
4. "Y" configuration.
5. Class 125.
6. Screen shall be type 304 stainless steel with 1/16" (0.062") perforations.
7. Furnish with ¾" NPT blowdown outlet with ball valve and hose thread cap
8. Furnish with threaded connections.

PART 3 - EXECUTION

A. Examine strainer interior for cleanliness and freedom from foreign matter.

B. Examine threads on strainer and mating pipe for form and cleanliness.

C. Do not attempt to repair defective strainers; replace with new.

3.2 INSTALLATION

A. Strainers shall be installed at the inlet to each pump, control valve, water pressure reducing valve and solenoid valve, and elsewhere as indicated on the drawings.

B. Locations and orientation shall be as recommended by the manufacturer for proper operation, and to facilitate proper maintenance access and removal of internal screening apparatus.

3.3 ADJUSTING

A. Clean strainer mesh after piping systems have been tested and put into service but before final adjusting and balancing.

END OF SECTION 22 17 30

SECTION 22 18 11
BLADDER TYPE EXPANSION TANKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies bladder type expansion tanks and includes materials and basic installation instructions.

B. See drawings for specific sizes; materials and installation methods pertaining to this project.

C. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of bladder type expansion tanks of sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 CODES AND STANDARDS

A. ASME Compliance: Manufacture and install bladder type expansion tanks in accordance with ASME Section VIII.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide bladder type expansion tanks as manufactured by one of the following:

1. Amtrol, Inc.
2. Bell and Gossett ITT; Fluid Handling Div.
3. John Wood Company (Alco Industries)
4. Taco, Inc.

2.2 GENERAL

A. Provide bladder type expansion tanks of the size and type as indicated on the drawings for use in closed potable water systems.

2.3 CONSTRUCTION

A. Bladder type tanks shall be designed, constructed and stamped in accordance with Section VIII, Division I of ASME Boiler and Pressure Vessel Code and rated for a maximum working pressure of 125 psi at 240°F.

B. Tank liner shall be polypropylene. Tank fixed diaphragm shall be heavy duty Butyl NSF/ANSI Air 61. Tank shall be prime coated and shall be provided with Schrader air valve with EPDM seat.

C. Units shall have stainless steel or bronze system connections.

D. Floor-mounted units shall be furnished with lifting rings, and have the system connection and charging valve at the tank top and tank drain connection at the bottom.

E. Where scheduled, expansion tanks shall have an internal replaceable elastomer bladder with the minimum acceptance volume and factory precharge pressure as indicated.

F. Furnish floor mounted tanks with a steel base ring for vertical mounting.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions where bladder type expansion tanks are to be installed.

B. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION

A. Install in-line expansion tanks supported from piping.

B. Install expansion tanks on floor as indicated, in accordance with manufacturer's instructions.

C. Vent and purge air from domestic water system, charge tank with proper air charge as recommended by manufacturer.

D. Provide a shutoff isolation valve at each expansion tank connection. Remove handle and wire to valve. Tag valve – "Valve to be closed only by authorized personnel."

END OF SECTION 22 18 11

SECTION 22 19 10
WATER FLOW SUB-METERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section specifies requirements for secondary water meters. The primary (building) water meter is provided by the local water utility.

B. Furnish all equipment, materials, labor, and supervision necessary to make all required furnish, install, and integrate secondary water meters as described herein.

C. The building water meter is to be provided by the local water utility and installed by this Contractor.

1.3 CODES AND STANDARDS

A. Displacement-Type Water Meters shall comply with AWWA Standard C700.

B. Compound-Type Water Meters shall comply with AWWA Standard C702.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. For Electronic Flow Meters:

1. Onicon
2. Hofer Flow Controls
3. Flow Technology

B. For Displacement-Type or Compound-Type Water Meters:

1. AAB Water Meters
2. Carlon Meter Co.
3. Census
4. Hersey Products
5. Mueller Co.
6. Neptune

2.2 ELECTRONIC FLOW METERS

A. Insertion type flow meters shall be provided with all installation hardware necessary to enable insertion and removal of the meter without system shutdown

B. Flow meters shall be hand insertable up to 150 psi.

C. Flow meter shall be a dual turbine design, with two contra-rotating axial turbines.

D. Turbine revolutions shall be sensed via an electronic, impedance-based sensing and an averaging circuit to reduce measurement errors due to swirl and flow profile distortion.

E. Each flow meter shall be individually wet-calibrated against a primary volumetric standard that is accurate to within 0.1% and traceable to NIST*.

F. A certificate of NIST traceable calibration shall be provided with each unit.

G. Accuracy:

1. Within ± 0.5% of rate at the calibrated velocity
2. Within ± 1% of rate over a 10:1 turndown (3.0 to 30 ft/s)
3. Within ± 2% of rate over a 50:1 turndown (from 0.4 to 20 ft/s).

H. Output signal shall be a 0-15 V square wave pulse.

I. Furnish with BACnet integration capability for networking of the meter into the building automation system.

2.3 DISPLACEMENT-TYPE WATER METERS

A. Pressure Rating: 150-psig working pressure.

B. Body Design: Nutating disc; totalization meter.

C. Registration: In gallons or cubic feet as required by utility.

D. Case: Bronze.

E. End Connections: Threaded.

2.4 COMPOUND-TYPE WATER METERS

A. Pressure Rating: 150-psig (1035-kPa) working pressure.

B. Body Design: With integral mainline and bypass meters; totalization meter.

C. Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility company.

D. Case: Bronze.

E. Pipe Connections: Flanged.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRONIC FLOW METERS

A. The flow meter shall be installed in the piping of the system to be measured.

B. Provide the required full port ball valve teed into the main, of diameter as required by the meter manufacturer.

C. Provide the required fittings with required thread patterns, as indicated by the meter manufacturer.

D. Terminate control wiring as recommended by the meter manufacturer and per the NEC.

3.2 CONNECTIONS

A. Piping

1. Securely thread meter in place, utilizing appropriate thread dope materials.
2. Tighten to torque range as recommended by the meter manufacturer.
3. Allow, at a minimum, the manufacturer’s straight pipe diameters upstream and downstream of the meter.

END OF SECTION 22 19 10

SECTION 22 19 40
NATURAL GAS SUB-METERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section sub-meters for natural gas systems installed inside or outside above grade, and includes materials, testing and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

C. Natural gas sub-meters shall be furnished by the Plumbing Contractor and installed into the piping system by the Plumbing Contractor, wiring is by the Controls Contractor.

1.3 CODES AND STANDARDS

A. All natural gas systems shall be installed in accordance with the Local Mechanical Code and all requirements of the local authorities having jurisdiction.

B. All natural gas systems shall comply with the latest "International Fuel Gas Code" and local utility requirements.

C. Gas regulators shall be ANSI Z21.18 certified.

PART 2 - PRODUCTS

2.1 GAS SUB-METERS

A. Acceptable Manufacturers:

1. Actaris U.S. Gas Inc., “Dattus”
2. Approved equal (prior to receipt of bids).

B. Operation:

1. Meters shall be capable of reading the required flow (as scheduled on drawings) at the required pressure (also scheduled on drawings) to within 1% accuracy.
2. Units shall utilize solid state electronics and static measurement technology. The operation shall be based on the fluidic oscillation principle comprised of a flow conditioner, jet nozzle formation and a fluidic oscillator chamber.
3. Maximum operating pressure: 150 psig.
4. Units: Cubic Feet.
5. Operating temperature range: -40F to 140F.
6. Meters shall communicate with the Building Automation System via modbus RTU protocol

C. Construction

1. External cover shall be constructed of Acrylonitrile Styrene Acrylate (ASA).
2. Index housing shall be constructed of UV stabilized polycarbonate.

3. Measurement unit shall be constructed of cast aluminum A356T6.

D. Connections:

1. Furnish with flanged inlet and discharge pipe connections, of sizes as indicated on drawings.
2. If not indicated, provide both inlet and discharge sizes shall be equal to the downstream pipe size.

E. Power Supply

1. Two (2) 3.6V, D cell lithium batteries.
2. Typical life: 8 to 11 years.

F. Monitoring

1. Furnish with BACnet integration capability for networking of the meter into the building automation system.
2. Furnish with four (4) configurable and user scalable pulse outputs. Output configuration shall be selectable, with available formats as follows:
   a. Uncorrected volume.
   b. Corrected Volume (Fixed Factor Pressure).
   c. Alarm Outputs, refer to next item.
3. Alarms:
   a. Oscillating sensors: failure, warning, contamination.
   b. Battery out of life.
   c. Flow rate out of range.
   d. Temperature out of range.
4. Contacts for configurable outputs shall utilize form-A dry contacts.
5. Pulse outputs shall be 250ms pulse duration.

PART 3 - EXECUTION

3.1 GENERAL

A. Install gas sub-meters as shown on the drawings in accordance with manufacturer's requirement.

B. Gas piping or meters shall not be used as grounding electrodes.

3.2 INSPECTION, TESTING, AND PURGING

A. All gas meters installed in gas piping systems shall be required to withstand the same inspections and testing as the piping system.

3.3 SUB-METER INSTALLATION

A. Connections to the piping system shall be made to meet the standards required for pipe fittings and joints, as specified in the piping specification section. Fasteners for flanged joints shall be tightened per manufacturer's recommendations.

B. Install meters properly so flow through the meter is oriented in the direction recommended by the manufacturer.

C. Wiring connections shall be weatherproof, and shall be installed per NFPA 70.

END OF SECTION 22 19 40

SECTION 22 20 10
EQUIPMENT IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies plumbing system equipment identification and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide identification as manufactured by one of the following:

1. Brady Corporation
2. Brimar Industries, Inc.
3. Craftmark Identification Systems
4. DuraLabel/Graphic Products
5. Kolbi Pipe Marker Co.
6. Marking Services, Inc.
7. Seton Identification Products

2.2 EQUIPMENT NAMEPLATES

A. Nameplates shall be laminated phenolic with black surface and white core. Use 1/16" thick material for plates up to 2" by 4". For larger sizes use 1/8" thick. Letters and numbers shall be a minimum of 1/2" high.

PART 3 - EXECUTION

3.1 EQUIPMENT IDENTIFICATION

A. Provide nameplates to identify all specified equipment with letters and numbers matching equipment designation as indicated on the drawings.

B. Nameplates shall be fastened by use of stainless steel sheet metal screws.

C. Where equipment does not have a location for mounting of a nameplate, provide a stencil identification.

1. Stencils shall be made with a color which stands out against the equipment finish color. Stencils shall be a minimum of 2" high.
2. Apply one coat of lacquer or varnish over the stencils for protection.
3. Nameplates and stencils shall be applied after any field painting of equipment.

D. Stencils shall be made with a color which stands out against the equipment finish color. Stencils shall be a minimum of 2" high.

E. Apply one coat of lacquer or varnish over the stencils for protection.

F. Nameplates and stencils shall be applied after any field painting of equipment.

END OF SECTION 22 20 10

SECTION 22 20 20
EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies insulation materials and installation methods common to more than one section of Division 22.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all insulation work described in this Section.

1.3 QUALITY ASSURANCE

A. Installing contractor shall have at least 3 years successful installation experience on projects with mechanical insulation similar to that required for this project.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver insulation, coverings, cements, adhesives and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.

B. Protect insulation against dirt, water, chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

C. Replace damaged insulation which cannot be satisfactory repaired, including insulating with vapor barrier damaged and moisture-saturated insulation.

D. The insulation installer shall advise the General Contractor as to requirements for protection of the insulation work during the remainder of the construction period (after the installation of insulation), to avoid damage and deterioration of the finished insulation work.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Unless otherwise noted, and subject to compliance with Specifications, provide insulation materials from the manufacturers specified below:

1. Fiberglass Equipment Insulation

a. Owens Corning

b. Knauf

c. CertainTeed

d. Johns Manville

2. Closed Cell Elastomeric Insulation
   a. Insul-Tube
   b. K-Flex USA
   c. Nomaco Kflex
   d. Techlite Insulation
   e. Thermacel

2.2 GENERAL

A. Provide all insulation materials (insulation, jackets, fitting covers, adhesives, cements, mastics, sealers and finishes) with a flame-spread index of 25 or less and smoke developed index of 50 or less, as tested under procedure ASTM E-84 (NFPA 255).

2.3 FIBERGLASS EQUIPMENT INSULATION

A. Factory applied all service jacket shall be white, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

B. Insulate the following equipment with fiberglass equipment insulation with all-service jacket (thickness as indicated), having a density of 3.0 pounds per cubic foot.

C. Apply the following fiberglass insulation thickness schedule to the pipe size and type:

Fiberglass Piping Insulation Thickness Schedule					
Pipe Type	Pipe Diameter				
	0 to 1”	1-1/4” to 2”	2-1/2” to 4”	5” and 6”	8” and above
Roof Drain Sumps	1”	1”	1”	1”	1”
Domestic Hot Water Storage Tanks	3”	3”	3”	3”	3”

2.4 CLOSED-CELL ELASTOMERIC

A. Insulate the following piping and fittings with closed cell elastomeric insulation.

B. Closed cell elastomeric pipe insulation shall comply with ASTM C 534 Type I.

C. Refer to the following Pipe Insulation Thickness Schedule:

Closed-Cell Elastomeric Piping Insulation Thickness Schedule					
Pipe Type	Pipe Diameter				
	0 to 1”	1-1/4” to 2”	2-1/2” to 4”	5” and 6”	8” and above
Water Cooler Traps and Wastes	1/2”	1/2”	1/2”	1/2”	1/2”
Floor Drain Sumps Receiving Cooling Coil	1”	1”	1”	1”	1”

Condensate					

PART 3 - EXECUTION

3.1 GENERAL

A. Install insulation products according to manufacturer's printed instructions, in compliance with recognized industry standards and this specification.

B. Install all insulation over clean dry surfaces. Insulation must be dry and in good condition. Wet or damaged insulation is not acceptable.

C. Install all insulation only after the completion of system pressure tests and leakage tests and installation of heat trace.

D. Install insulation materials with smooth even surfaces. Use full lengths of insulation where possible, only cut where necessary. Do not use cut pieces or scraps abutting each other.

E. Repair existing equipment insulation where removed to make new connections, to add controls, or where damaged by new construction. Use same insulation as specified for new service.

F. Where existing asbestos insulation is discovered or suspected notify the building Owner immediately so it can be removed under a separate asbestos removal contract.

G. Install insulation materials with smooth and even surfaces. Rework all poorly fitted joints. Do not use joint sealer or mastic as filler for joint gaps and excessive voids resulting from poor workmanship. Apply using staggered joint method for multi-layer installations, applying each layer of insulation separately.

H. Install insulation materials with smooth even surfaces. Use full lengths of insulation where possible, only cut where necessary. Do not use cut pieces or scraps abutting each other.

I. Coat insulated surfaces without vapor barrier with a layer of insulating cement, troweled to a smooth and continuous surface. Fill in seams, broken edges, and depressions. Cover over wire mesh and joints with cement sufficiently thick to remove surface irregularities.

J. Maintain the integrity of factory-applied vapor barrier jacketing on all insulation, protecting it against puncture, tears or other damage.

K. For field-applied all-service vapor barrier jacketing, neatly fit and tightly secure. Lap seams 2 inches minimum. Seal all joints with adhesive. Tape with 3 inch matching pressure-sensitive tape or 3 inch glass fabric and mastic.

L. Removable insulation: Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance as scheduled and as required for inspection such as vessel covers, fasteners, flanges, frames, etc.

M. On hot equipment, do not insulate handholes, clean-outs, ASME stamps and manufacturers nameplates. Bevel and seal insulation edges at these locations. On cold equipment (to prevent condensation), provide removable insulation sections over these locations. Tag surfaces to indicate what is concealed.

N. Miter rigid fiberglass equipment insulation to fit shape of equipment and secure in place with steel bands at 12 to 18 inches on center. Seal all joints with matching pressure sensitive joint sealing tape.

3.2 PROTECTION

A. Replace damaged insulation which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.

B. The insulation installer shall advise the General and the Plumbing Contractor as to requirements for protection of the insulation work during the remainder of the construction period (after the installation of insulation), to avoid damage and deterioration of the finished insulation work.

END OF SECTION 22 20 20

SECTION 22 21 11
HIGH EFFICIENCY GAS-FIRED WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies domestic water gas-fired condensing type water heaters and accessories, and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of water heaters of types and capacities required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 SPECIFIC CODES AND STANDARDS

A. Electrical Component Standard: Provide components complying with NFPA 70 "National Code".

B. Provide water heater components which are UL listed and labeled.

C. NFPA Compliance: Install gas-fired water heaters in accordance with requirements of NFPA 54, "National Fuel Gas Code".

D. AGA/ANSI Compliance: Provide water heaters with temperature and pressure relief valves which are sized, listed, and labeled in accordance with ANSI/AGA Standard Z21.10.

E. AGA Labels: Provide water heaters and water heater temperature and pressure relief valves which are listed and labeled by American Gas Association.

F. ASHRAE Compliance: Provide water heaters with Performance Efficiencies not less than prescribed in ASHRAE 90A, "Energy Conservation in New Building Design".

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data including rated capacities and efficiencies of selected model clearly indicated, operating weights, furnished specialties and accessories, and installation and start-up instructions.

B. Shop Drawings: Submit manufacturer's assembly type shop drawings indicating dimensions, required clearances, and methods of assembly of components.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for electrical power supply wiring to water heaters. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation of water heaters and controls. Differentiate between portions of wiring that are factory-installed and portions that are to be field-installed.

D. Maintenance Data: Submit maintenance data and parts lists for each type and size of water heater, control, and accessory, including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual, in accordance with requirements of Division 1.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Handle water heaters and components carefully to prevent damage, breaking, denting, and scoring. Do not install damaged water heaters or components; remove from site and replace with new.

B. Store water heaters and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

C. Comply with manufacturer's rigging and installation instructions for unloading water heaters, and moving units to final location for installation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide direct vent gas-fired water heaters of one of the following:

1. Aerco or approved equal

2.2 GENERAL

A. Provide gas-fired condensing water heaters of sizes and capacities as indicated on the drawings.

B. Water heater shall contain automatic controls, gas burner, 150 psig rated ASME labeled vertical storage tank, ducted combustion air intake system, direct vent system, drain valve, gas regulator and AGA/ASME temperature and pressure relief valve.

C. Water heater shall be of gas fired, condensing fire tube type design with a modulating power burner and positive pressure discharge.

D. The water heater will operate to maintain a constant header temperature outlet to +/-2°F.

E. Unit shall operate with an Inverse Efficiency curve, with known Part Load Value Efficiencies. Maximum efficiency shall be achieved at a minimum firing input.

F. Main Header outlet temperature shall not be more than +/-2°F from setpoint at any point of operation.

2.3 BURNER

A. Burner shall be capable of 20:1 turndown of firing rate for natural gas units and a 14:1 for propane units, without loss of combustion efficiency.

2.4 HEAT EXCHANGER

A. Heat exchanger/combustion chamber shall incorporate a helical fire tube design that will be self supporting, baffle free, and warranted to withstand thermal shock.

B. Heat exchanger shall be ASME stamped for a working pressure not less than 150 psig.

2.5 FLUE

A. Exhaust manifold shall be of corrosion resistant porcelain enameled cast iron, with a 6" diameter flue connection. Exhaust manifold shall have a gravity drain for the elimination of condensation.

B. Materials shall conform with all manufacturer's recommendations and shall include a Stainless Steel AL-29-4C Positive Pressure U/L Listed Vent System.

2.6 CONTROLS

A. The water heater control system shall be segregated into three separate components:

1. Control Panel
2. Power Box
3. Input/Output Connection Box.

B. The entire system shall be Underwriters Laboratories Recognized. The control panel shall utilize BacNet open protocol to interface with third party Building Automation Systems (BAS).

C. Water heater shall include integral factory wired operating controls to control all operation and energy input of the water heater. Control of discharge water temperature shall be set through an internal setpoint with an adjustment of 50°F to 220°F.

D. The controller shall have the ability to vary boiler input throughout its full range to maximize the condensing capability of the water heater and without header temperature swings.

E. The water heater shall have LCD display for monitoring of all sensors and interlocks.

F. Safety Controls

1. Equip with automatic gas shutoff device to shut off entire gas supply in event of excessive temperature in tank, and pilot safety shutoff.

G. Control Panel

1. The control panel shall consist of 6 individual circuit boards utilizing state-of-the-art surface-mount technology, in a single enclosure. These circuit boards shall be defined as follows:
   a. Display board incorporating LED display to read temperature, and a VFD display module for all message annunciation
   b. CPU board which houses all control functions
   c. Electric low water cutoff board with test and manual reset functions
   d. Power supply board
   e. Ignition/stepper board incorporating flame safeguard control
   f. Connector board.

2. Each board shall be individually field replaceable.
3. The combustion safeguard/flame monitoring system shall utilize spark ignition and a rectification type flame sensor.

4. The control panel hardware shall support both RS-232 and RS-485 remote communications.
5. The controls shall annunciate water heater & sensor status and include extensive self-diagnostic capabilities that incorporates a minimum of 8 separate status messages and 34 separate fault messages.
6. The control panel shall incorporate three self-governing features designed to enhance operation in modes where it receives an external control signal by eliminating nuisance faults due to over-temperature, improper external signal or loss of external signal. These features are called
   a. Setpoint High Limit: Setpoint High Limit allows for a selectable maximum water heater outlet temperature and acts as temperature limiting governor. It is a PID function that automatically limits firing rate to maintain outlet temperature within a 0 to 10 degree selectable minimum operating temperature.
   b. Setpoint Low Limit
   c. Failsafe Mode: Failsafe Mode allows the water heater to switch its mode to operate from an internal setpoint if its external control signal is lost, rather than shut off. This is a selectable mode; hence the control can be set to shut off the unit upon loss of external signal if so desired.

7. The water heater control system shall incorporate the following additional features for enhanced external system interface:
   a. System start temperature feature
   b. Pump delay timer
   c. Auxiliary start delay timer
   d. Auxiliary temperature sensor
   e. mA output feature which allows for simple monitoring of either temperature setpoint, outlet temperature, or fire rate
   f. Remote interlock circuit
   g. Delayed interlock circuit
   h. Fault relay for simple remote fault alarm.

2.7 GAS TRAIN

A. Water heater shall utilize an electric single seated safety shutoff valve with proof of closure switch in its gas train and incorporate dual over-temperature protection with manual reset in accordance with ASME Section IV and CSD-1.

B. The water heater shall have individually isolating shutoff valves for service and maintenance.

C. The water heater shall require a minimum gas pressure of 8.5" W.C. with a FM gas train.

2.8 ENCLOSURE AND INSULATION

A. Provide outer steel jacket with baked enamel finish.

B. Insulate tank with vermin-proof double density insulation.

2.9 ACCESSORIES

A. Furnish with an integral ASME approved temperature and pressure relief valve

B. Furnish with integral drain valve

C. Furnish with an integral cold water dip tube

D. Furnish remote mounted condensate neutralization sump.

E. Furnish with direct vent kit

PART 3 - EXECUTION

3.1 GENERAL

A. Examine areas and conditions under which water heaters are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.

B. All equipment shall be installed plumb and level, firmly anchored in locations indicated and in accordance with the equipment manufacturers' recommendations.

C. All equipment shall be installed with adequate clearance provided for routine maintenance and servicing.

3.2 INSTALLATION

A. All aspects of the installation of domestic water heaters shall be in strict accordance with manufacturer's installation instructions.

B. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

C. Orient so controls and devices needing service and maintenance have adequate access.

D. Support: Place units on a 4" high concrete housekeeping pad.

3.3 CONNECTIONS

A. Connect hot cold water piping to units with shutoff valves, dielectric nipples, and unions. If hot and cold water piping connections to water heater require dielectric separation, provide stainless steel union, stainless steel nipple, stainless steel coupling and dielectric nipple at each connection.

B. Extend relief valve discharge to down to floor.

C. Connect gas supply to gas line with drip leg, tee, gas cock, and union; full size of pipe sizes shown on the drawings.

D. Reduce gas line size at water heater connection.

E. Locate piping so as not to interfere with service of unit.

F. Connect combustion air intake pipe and flue gas vent pipe to unit as required by manufacturer.

G. Electrical Connections: Power wiring and disconnect switches are specified in Division 26.

1. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

H. Connect to supply gas regulator for proper gas regulation with a 1.25" NPT connection.

3.4 FIELD QUALITY CONTROL

A. Start-up:

1. Engage the services of a factory trained and qualified representative to perform initial unit start-up.
2. Representative shall test and adjust water heaters in accordance with manufacturer's start-up instructions and requirements.

B. Check and calibrate controls, adjust burner for maximum efficiency.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative for two (2) hours to train Owner's maintenance personnel to adjust, operate, and maintain water heaters.

END OF SECTION 22 21 11

SECTION 22 24 11
SKID MOUNTED DOMESTIC BOOSTER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies skid mounted domestic water booster pump packages including factory installed and loose shipped accessories, and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor, and supervision necessary to install and perform all work described in this section.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. Pump system manufacturer must have no less than 20 years experience as a designer and manufacturer of domestic water pumping systems for commercial buildings.

2. Manufacturer must have designed, built, and supported not less than 5,000 pump systems and been under continuous management for not less than ten years.

3. Manufacturer's testing instrumentation must be traceable to NIST standards. Include current certifications with substitution request. Manufacturer must be ISO 9000 certified.

B. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. UL and NEMA Compliance:

1. Provide electric motors and components which are listed and labeled by Underwriters Laboratories and comply with NEMA standards.

2. Comply with UL 778 for motor-operated water pumps.

D. Design Criteria:

1. The Drawings indicate sizes, profiles, connections, and dimensional requirements of plumbing pumps, and are based on the specific manufacturer types and models indicated. Pumps having equal performance characteristics by other named acceptable manufacturers may be considered, provided deviations in dimensions and profiles and efficiencies do not change the design concept or intended performance as judged by the Engineer.

2. All packaged equipment shall be independently Third Party labeled as a system suitable for the intended use by a Nationally Recognized Testing Laboratory in ac¬cordance with OSHA Federal Regulations, and NFPA Pamphlet 70, National Elec¬tric Code Article 90-7.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements provide domestic water booster pump packages as manufactured by one of the following:

1. Bell and Gossett
2. Syncroflo
3. Systecon
4. Liqui-Trol
5. Grundfos

2.2 GENERAL

A. Furnish a prefabricated, skid mounted, variable speed domestic water pressure booster system as specified herein and of size and quantities as indicated on the drawings.

B. The system shall be factory prefabricated.

C. All branch and header wetted parts shall be minimum 304 stainless steel.

2.3 BASE CONSTRUCTION

A. All skid members must be properly designed structural steel, to adequately support the weight of the entire system, including piping and motors, and resist bending during transportation.

2.4 FACTORY PIPING AND COMPONENT JOINTS

A. All branch and header connections shall be flanged or welded with the only thread connections located at the pump discharge.

2.5 FIELD CONNECTIONS

A. Furnish flanged schedule 40 suction and discharge headers, which can be reversed in the field.

B. The only field connections required shall be to system headers, expansion tank, over-temperature drain tube, and one incoming power connection at the control panel.

2.6 PUMPS AND MOTORS

A. Pumps shall be single stage end-suction design with cast iron bronze-fitted or stainless steel construction, equipped with sleeve-mounted mechanical shaft seals and close coupled to a high efficiency motor with class F insulation.

B. Pump designs that do not have shaft sleeves shall not be acceptable.

C. Pump shall be fitted with single inside mechanical seal with carbon vs. ceramic faces, stainless steel spring and hardware and Buna-N elastomers.

D. Pumps shall be selected closest to the best efficiency point.

E. Motors shall be non-overloading at duty point.

F. To protect the pump against overheating, provide a mechanical over-temperature protection device on the pump discharge that will divert flow to drain when water temperature exceeds 140° F.

2.7 ISOLATION VALVES

A. Provide isolation valves on the suction and discharge of each pump.

B. Valves shall be lug style butterfly valves with hand lever operator rated for a minimum 200psig W.P.

C. Valves shall be certified to NSF 61 drinking water standards.

2.8 CHECK VALVES

A. Provide a wafer style check valve to prevent back flow of water on each pump discharge.

B. Check valve shall be manufactured from gray iron and shall be rated for a minimum of 200psig W.P.

C. All contact surfaces shall be suitable for potable water service.

2.9 PUMP SEQUENCING

A. The controller shall optimize power consumption based on flow, VFD speed, and power consumption. As a backup, a factory set pressure switch shall sequence pumps when system pressure falls below the setpoint. Automatic sequencing shall include the following features:

1. Flow sequencing. Flow sensor shall be included and installed in piping.
2. Power sequencing, programmable in horsepower not Watts.
3. Pressure sequencing.
4. End-of-curve protection, based on pump differential, with 2% accuracy.
5. VFD speed sequencing.
6. Lead pump shutdown feature that can be enabled or disabled by the operator.
7. Low-flow test feature testing pressure, power, VFD speed, and flow (flow sensor), to reduce pump short-cycling, pressure swings, power surges, and motor wear.
8. Tank pressurization sequence to increase the energy stored in the tank prior to shutdown.
9. Time clock to disable lead-pump shutdown during building occupancy.
10. Sequence shifting that adjusts the pump sequence when any pump is disabled.
11. Successive and 24 hour alternation of equal capacity pumps.
12. Pump overlap during 24-hour alternation.
13. Lag pump exerciser function.
14. Special sequencing to reduce surges during power restoration.
15. Sequential sequencing of lag pumps.
16. Minimum run and stop delay timer for each pump.
17. Field adjustable time delay for lag pump pressure start signals.

18. Field adjustable low suction pressure alarm.

19. Field adjustable selection to enable / disable limited auto reset of low suction and high system pressure alarms.

2.10 POWER AND CONTROL PANEL

A. Furnish a power and control panel in NEMA 1 enclosure complete with programmable controller, epoxy-coated backpan, operator interface, and 120V control circuit transformer.

B. The complete assembly shall have the UL listing mark for industrial control panels.

C. Provide circuit-breaker protection, not fuses that require replacement. The primary control power circuit breaker shall comply with UL file code 489 and the secondary circuit breaker with UL file code 1077.

D. All components must conform to the IP10 finger safe design to protect against accidental contact.

E. All internal power wiring must be 90° C rated per UL508A.

F. Size power wire in accordance with UL508A Table 28.1.

G. Control panel must meet 65,000 SCCR Rating.

2.11 OPERATOR INTERFACE

A. Furnish with an integral, factory wired 3.7" color touch screen operator interface.

B. The touchscreen interface shall be flush mounted in the door of the control panel.

C. The touchscreen shall have the following features:

1. 120 x 64 resolution, 3.7" screen size, backlit STN liquid crystal interface display.

2. Serial port (for PLC communication), USB port (for programming), and Compact Flash port (for troubleshooting and field-loading program changes).

3. The HMI shall be capable of direct communication with the VFD, in the event of a PLC failure.

D. The following data shall be accessible through the operator interface:

1. System status including flow rate (GPM), current system pressure and setpoint, pump run status, the current speed of the pumps (in %), and the method of speed control. Display system status on all user screens.

2. Usage history shall record the maximum instantaneous flow, along with the date and time. Overall and current day totalized flow, pump starts, and pump run hours are also recorded. Usage history may be reset.

3. A Set Points Menu system for adjusting setpoints. Display and adjust flow, pressure, differential pressure, VFD speed, power, minimum speed, lead pump shutdown mode, and tank pressurizer set points and time delays. Restore to either factory defaults or the last saved field defaults. Protect adjustable settings with a password.

4. Alarm History of the past 200 alarms. Each log shall include individual pump run status, system pressure and run setpoint, alarm type and the date and time. Alarm Type shall be in plain English, not codes requiring a reference list.

5. Alarm List of all possible alarms and their current status. Display any current alarms on all user screens.

6. Startup instructions and checklist.

7. The HMI shall include a method for transferring data

8. System information shall automatically copy to an installed compact flash drive every minute, plus an additional entry for each alarm condition.
9. Include fault codes from the PLC and the VFD.
10. Copy usage data to the drive daily.
11. Data shall be stored in a text file, readable by non-proprietary software.

E. HMI Software shall allow for program changes to the HMI and PLC to be transferred via the compact flash drive. Operator interface shall be provided with a serial interface conforming to the open BacNet integration protocol. All parameters, data, setpoints, and diagnostic information monitored and retained by the integral unit controller shall be accessible though the remote integration interface.

2.12 EMERGENCY CONTROLS AND ALARMS

A. Furnish skid with integral temperature relief valves at each pump, low suction, low system and high system pressure alarms, indication of first activated alarm, pulsing alarm horn with silence function, and individual alarm auxiliary contacts, time delays, and indicating lights.

B. Provide backup sequencing and controls to provide temporary operation when the touchscreen or PLC is inoperable or removed.

2.13 PROGRAMMABLE LOGIC CONTROLLER (PLC)

A. The PLC shall be installed on the control panel base pan, not the door, to protect it from damage.

B. The PLC manufacturer shall be clearly marked on the controller, and non-proprietary.

C. The PLC shall continue to function even if the touchscreen is broken, damaged, or removed.

D. The PLC shall have the following features:

1. 32,000 steps of built-in program memory.
2. 7680 auxiliary relays.
3. 320 timers.
4. 235 counters.
5. 8000 data registers.
6. 24,000 extension registers.
7. 24,000 extension file registers.

2.14 VARIABLE FREQUENCY DRIVES

A. Each pump shall have its own variable frequency drive with the following features:

1. Voltage source, GTR or IBGT power transistor based inverter - PWM Type.
2. Use a high carrier frequency to reduce drive and motor noise.
3. Shall be capable of operating in an ambient temperature between 15 degrees F and 100 degrees F and a line voltage variation of less than 10 percent.
4. Self protection features shall include: under voltage and over voltage protection, current overload protection, short circuit protection, power failure protection, ground fault protection, and over-temperature protection.
5. Include a four-digit LED readout to indicate the following: drive enabled, output frequency, and all VFD fault conditions.

B. The drive shall automatically restart after any of the following: overload over-voltage, converter over-current, inverter over-current, or power failure.

C. The following drive parameters shall be user adjustable: acceleration speed (1 to 300 seconds), deceleration speed (1 to 300 seconds), minimum speed, and maximum speed.

D. The drive shall have a front mounted "HAND-OFF-AUTO" selector switch and a potentiometer for adjusting drive speed in the "HAND" position.

E. Minimum 1000,000 SCCR.

F. The VFD shall use the following energy saving techniques

1. Slows down the motor
2. Reduce current
3. Reduces voltage
4. Evaluates 6 motor characteristics to further increase efficiency

G. The VFD shall communicate with the PLC with a DIGITAL connection, with the following capabilities:

1. Able to modify 300 different VFD parameters through the PLC and HMI
2. Read all VFD data and communicate it to the PLC, HMI, and write to the compact flash drive.

H. VFD Dust Protection

1. Install variable frequency drives smaller than 40 HP inside a NEMA 1 control panel, or provide dust protection to an externally-mounted drive.
2. Provide fans to cool control panels with internally-mounted VFD's. Fans shall produce positive cabinet pressure, to prevent dust infiltration.
3. Filter all incoming air.

2.15 INSTRUMENTATION

A. Pressure Gauges:

1. Furnish each system with factory installed pressure gauges for indicating suction and system discharge pressure, and control power light.
2. All pump or header-mounted pressure gauges shall be 4½" glycerin filled gauges. All panel mounted gauges shall be 2 1/2" glycerin filled gauges.
3. Gauges shall have a stainless steel case and crimp ring, copper alloy movement with the case connection sealed with EPDM "O"-ring.
4. Gauges shall be according to ASME B40.100, Grade A and shall have an accuracy of 1% of span.

B. System Pressure Transmitters:

1. Factory mount the pressure transmitter inside the control panel.
2. Digital pressure transmitter shall be connected to the system header.
3. The transmitter shall have 1.0% accuracy, stainless steel wetted parts and a waterproof enclosure.
4. Transmitter shall be IP67 rated, and capable of withstanding over pressurization of double its range.

5. The transmitter shall use a digital 1-6 kHz pulse output that can be directly sent to a programmable logic controller (PLC) without requiring an additional analog module for measuring current.
6. The transmitter zero set point must be capable of field calibration.

2.16 MANUFACTURER'S WARRANTY

A. The complete pumping system shall be guaranteed in writing by the manufacturer for a period of one year from date of startup or eighteen months from shipment, whichever comes first, against defects in materials and workmanship.

B. Warranties and guarantees by the suppliers of various components in lieu of single-source responsibility by the manufacturer will not be accepted.

C. The PLC, Touchscreen HMI, and VFD's shall be warranted for 5 years by a single third-party.

PART 3 - EXECUTION

3.1 EXAMINATION

A. All equipment shall be installed plumb and level, firmly anchored in locations indicated and in accordance with the equipment manufacturer's recommendations.

B. All equipment shall be installed with adequate clearance provided for routine maintenance and servicing.

C. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

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

E. Electrical Wiring: Verify that electrical wiring installation is acceptable to equipment Installer.

3.2 MANUFACTURER'S TEST REQUIREMENTS

A. The booster system and its component parts shall undergo a complete operational flow test at the factory from zero to 100% design flow rate under the specified suction and net system pressure conditions.

B. This flow test shall be performed by supplying the control panel with the specified incoming voltage.

C. Each pump's performance shall be tested over its full range of flow.

D. All adjustments shall be set and all functions verified.

E. Components shall be tested for hydraulic shock, vibration, or excessive noise. Any parts found to be defective must be replaced prior to shipment.

F. Full documentation shall be maintained by the manufacturer showing flow rates, pressures, and amp draws for future service and troubleshooting.

3.3 PUMP INSTALLATION

A. Comply with HI 1.4 HI 2.4. As applicable

B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pump package to allow service and maintenance.

C. Connect piping to pump package.

D. Install electrical connections for power, controls, and devices.

E. Ground equipment according to Division 26 requirements.

F. Connect wiring according to Division 26 requirements.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

2. Check piping connections for tightness.

3. Clean strainers.

4. Perform the following startup checks for each pump before starting:

a. Verify bearing lubrication.

b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.

c. Verify that pump is rotating in the correct direction.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.

6. Start motor.

7. Open discharge valve slowly.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative for two (2) hours on two separate days to train Owner's maintenance personnel to adjust, operate, and maintain plumbing pumps.

END OF SECTION 22 24 11

SECTION 22 24 20
RECIRCULATION PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. Extent of domestic recirculation pump work required by this Section is indicated on drawings and schedules, and by requirements of this Section.

B. Provide all materials, equipment, labor, and supervision necessary to install and perform all work described in this section.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

B. HI Compliance: Design, manufacture, and install HVAC pumps in accordance with HI - "Hydraulic Institute Standards".

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

D. UL Compliance: Comply with UL 778 for motor-operated water pumps.

E. UL and NEMA Compliance: Provide electric motors and components which are listed and labeled by Underwriters Laboratories and comply with NEMA standards.

F. Circulators shall be UL Listed for indoor use and NSF Certified to NSF/ANSI 372.

G. Design Criteria: The Drawings indicate sizes, profiles, connections, and dimensional requirements of plumbing pumps, and are based on the specific manufacturer types and models indicated. Pumps having equal performance characteristics by other named manufacturers may be considered, provided deviations in dimensions and profiles and efficiencies do not change the design concept or intended performance as judged by the Engineer.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

A. Subject to compliance with requirements provide recirculation pumps as manufactured by one of the following:

1. Bell and Gossett
2. Paco
3. Taco
4. Grundfos

2.2 HOT WATER CIRCULATING PUMPS

A. Hot water circulating pumps shall be close-coupled, centrifugal inline style pumps.

B. Domestic water circulators shall be constructed of low-lead bronze or stainless steel with dynamically and one-piece hydraulically balanced bronze impeller, suitable for use in domestic water systems.

C. The circulator shall have a self-lubricating, maintenance free design with a field-serviceable and replaceable cartridge. The cartridge shall contain all the moving parts and no mechanical seal shall be required.

D. The maximum working pressure shall be 125 psi, maximum fluid temperature of 220°F, and minimum fluid temperature of 40°F.

E. Motor shall be resilient mounted, open-drip proof enclosure type. Single phase motors shall be furnished with built-in overload protection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. All equipment shall be installed plumb and level, firmly anchored in locations indicated and in accordance with the equipment manufacturer's recommendations.

B. All equipment shall be installed with adequate clearance provided for routine maintenance and servicing.

C. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

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

E. Electrical Wiring: Verify that electrical wiring installation is acceptable to equipment Installer.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4 HI 2.4. As applicable

B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Independently support inline pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Install continuous-thread hanger rods and elastomeric hangers of sufficient size to support weight of in-line circulators.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pump to allow service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps. Reduce piping only at pump.

D. Install electrical connections for power, controls, and devices.

E. Ground equipment according to Division 26 requirements.

F. Connect wiring according to Division 26 requirements.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative for one (1) hour to train Owner's maintenance personnel to adjust, operate, and maintain plumbing pumps.

END OF SECTION 22 24 20

SECTION 22 24 34
HYDRAULIC ELEVATOR PIT SUMP PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. Extent of sump pump work required by this Section is indicated on drawings and schedules, and by requirements of this Section.

B. Provide all materials, equipment, labor, and supervision necessary to install and perform all work described in this section.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

B. HI Compliance: Design, manufacture, and install pumps in accordance with HI - "Hydraulic Institute Standards."

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

D. UL Compliance: Comply with UL 778 for motor-operated water pumps.

E. UL and NEMA Compliance: Provide electric motors and components which are listed and labeled by Underwriters Laboratories and comply with NEMA standards.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.5 COORDINATION

A. Coordinate size and location of sumps with the General Contractor.

1.6 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements provide pumps as manufactured by one of the following:

1. Homa
2. Weil
3. Liberty
4. Zoeller
5. Stancor

2.2 PUMP CONSTRUCTION

A. Sump Pumps shall be simplex, vertical, centrifugal, direct connected, end suction, single stage, bronze fitted, complete with integral inlet strainer, operating controls and sump cover.

B. Casing: Epoxy coated class 30 cast iron with integral cast iron inlet strainer and legs to elevate the pump to permit flow into the impeller. Discharge companion flange shall be arranged for vertical discharge and suitable for plain-end pipe connection.

C. Impeller: Statically and dynamically balanced, open or semi-open, overhung, single suction, fabricated from cast bronze conforming to ASTM B-584, keyed to shaft and secured by a locking cap screw.

D. Pump and motor shaft stainless steel, with factory-sealed, grease-lubricated ball bearings.

E. Seals: Stainless steel carbon/ceramic.

F. Motor: Hermetically sealed, capacitor start, with built-in overload protection, with 10-foot, 3-conductor, waterproof cable and grounding plug.

2.3 BASIN

A. Fiberglass, minimum 24” diameter x 30” deep.

B. Cover: Provide perforated steel, round cover, with access openings for wiring and discharge piping.

2.4 CONTROLS

I. Controls shall be located within a NEMA 3R alarm enclosure remote from the pump and shall contain a UL508 approved switch with 25 foot piggyback electrical supply cord and audible and light alarms with dry contacts. Controller shall differentiate between oil and water. Controller, stainless steel probe and float switch shall alert maintenance personnel of high water or oil detected conditions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. All equipment shall be installed plumb and level, firmly anchored in locations indicated and in accordance with the equipment manufacturer’s recommendations.

B. All equipment shall be installed with adequate clearance provided for routine maintenance and servicing.

C. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

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

E. Basins: Install sump basins in indicated location. Brace interior of basin in accordance with manufacturer's instructions to prevent distortion or collapse during concrete placement. Set cover over basin and fasten to top flange of basin install so cover is flush with finished floor.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4 HI 2.4. As applicable

B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pump to allow service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install check valve on discharge side of pumps.

E. Install electrical connections for power, controls, and devices.

F. Ground equipment according to Division 26 requirements.

G. Connect wiring according to Division 26 requirements.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

2. Check piping connections for tightness.

3. Perform the following startup checks for each pump before starting:

a. Verify that pump is free to rotate by hand.

b. Verify that pump is rotating in the correct direction.

4. Start motor.

END OF SECTION 22 24 34

SECTION 22 27 10
LABORATORY AIR COMPRESSORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. Extent of air compressors work required by this Section is indicated on drawings and schedules, and by requirements of this Section.

B. Provide all materials, equipment, labor, and supervision necessary to install and perform all work described in this section.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain air compressors through one source from a single manufacturer.

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

C. UL and NEMA Compliance: Provide electric motors and components which are listed and labeled by Underwriters Laboratories and comply with NEMA standards.

D. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

E. Design Criteria: The Drawings indicate sizes, profiles, connections, and dimensional requirements of air compressors, and are based on the specific manufacturer types and models indicated. Air compressors having equal performance characteristics by other named manufacturers may be considered, provided deviations in dimensions and profiles and efficiencies do not change the design concept or intended performance as judged by the Engineer.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store air compressors in dry location.

C. Retain protective covers for control panels and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with air compressor manufacturer's written rigging instructions.

1.5 SUBMITTALS

A. Shop Drawings: Provide Shop Drawings, per requirements of Sections 22 01 10.

B. Operation and Maintenance (O&M) Manuals: Provide manuals, per requirements of Section 22 01 10.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements provide air compressors as manufactured by one of the following:

1. Quincy Compressor.
2. Atlas Copco
3. Kaeser

2.2 GENERAL REQUIREMENTS

A. Provide air-cooled, oil-free rotary screw air compressors of capacities as scheduled on drawings.

2.3 UNIT FEATURES:

A. Air intake filter/silencer with replaceable paper element
B. Air inlet valve/un-loader assembly
C. Two rotary lobe compressor elements flange mounted to gear box
D. Air-cooled intercooler and after-cooler with moisture separator and automatic/manual drains
E. Safety valves for low and high pressure circuits
F. Check valve
G. Discharge air service valve
H. Pressure lubrication system with:
   1. Gear type pump driven by main drive shaft
   2. Oil filter/spin-on type
   3. Oil level gauge
   4. Integral oil sump to gearbox
   5. Air-cooled oil cooler
I. Patented gearbox breathing system
J. D-flanged main drive motor and flexible coupling
K. Integral base frame for compressor and drive assembly
L. Axial flow cooling fan driven by separate TEFC motor
M. Full acoustical sound attenuating enclosure
N. Regulating system open/close intake valve for load/no load control
O. CSA/UL control cubical with starter's control transformer
P. Designed for 104ºF maximum ambient operating temperature
Q. An Integrated refrigerated dryer that will provide quality air to your system, with a pressure dew point low enough to supply clean dry air year round.

2.4 RECEIVERS

A. Receivers shall be of steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   1. Pressure Rating shall be at least as high as highest discharge pressure of connected compressors, and bearing appropriate code symbols.

2. Interior Finish: Corrosion-resistant coating.

3. Accessories shall include safety valve, pressure gage, drain, and pressure-reducing valve.

B. Mounting Frame: Fabricate mounting and attachment to pressure vessel with reinforcement strong enough to resist packaged equipment movement during a seismic event when base is anchored to building structure.

2.5 CONTROLS

A. Comply NEMA ICS 2 and UL 508.

1. Enclosure: Provide NEMA ICS 6, type 12 control panel unless otherwise indicated.

2. Motor Control: Shall be full voltage, combination magnetic type with undervoltage release feature and motor circuit protector type disconnecting means and short circuit protective device.

3. Control Voltage: Shall be 120V AC or less, using integral control power transformer.

4. Motor Overload Protection: Overload relay on each phase.

5. Starting Devices: Provide hand off automatic selector switch in cover of control panel, plus pilot device for automatic control.

6. Provide automatic control switches to alternate lead-lag compressors for duplex systems.

7. Instrumentation shall include inlet and receiver pressure gauges, hour meter, discharge-air and coolant temperature gauges, and control transformer.

8. Provide alarm signal device for connection to alarm system to indicate when backup compressor is operating.

B. Programmable Logic Controllers (PLC) will be used to implement operating logic. PLC has integral memory and EPROM backup. PLC shall control the automatic alternation of the compressors with provisions for simultaneous operation if required, and automatic activation of reserve unit if required. A lag alarm on control cabinet and contacts for the master alarm will be provided.

C. The complete control system and all electrical components shall be NEMA 12 and UL labeled.

D. The control system shall provide:

1. Full voltage motor starters with overload protection.

2. 120 volt control circuit transformers.

3. Visual and audible reserve unit alarm with isolated contacts for remote alarms and audio cancel.

4. Control cabinet shall have lighted HOA selector switches.

5. Panel mounted pressure gauge.

E. Provide with integral BacNet communication port and all necessary software to facilitate direct communication through a native BacNet network

2.6 REFRIGERATED COMPRESSED AIR DRYERS

A. Provide air-cooled refrigerated dryers for each air compressor sized for peak calculated demand. Include dew point monitoring.

B. Refrigeration system shall be non-cycling DX type with hot gas by-pass and automatic control. Refrigerant shall be R134a or approved equivalent.

C. Refrigeration lines shall be constructed with silver brazed or flared connections, securely mounted, and isolated from vibration with vibration loops. Control switches shall be mounted without connecting tubing. A liquid line filter/dryer shall be supplied. Refrigeration systems shall be cleaned, purged, evacuated, charged with refrigerant, leak checked and performance tested before shipment.

D. Dryer shall be sized to produce a 38°F dew point temperature.

E. Dryer shall be rated for 230 psig maximum working pressure with a pressure drop not to exceed 3.2 psid.

F. Heat exchangers shall be constructed with AISI stainless steel plates with press formed herringbone geometry. No pre-filter shall be required. Heat exchangers shall be fully encapsulated in non-degrading urethane foam insulation to prevent the loss of any cooling effect.

G. Dryer shall be equipped with a 2-stage fully insulated separator/filter with an integral Grade B - 3 micron coalescing filter.

H. Dryer shall be furnished with an automatic condensate drain assembly utilizing a timed factory pre-set solenoid drain with test button on front panel.

I. Dryer controls shall include:

1. On/Off switch
2. Power-On LED light
3. Dew point temperature bar graph indicator

2.7 WARRANTY

1. Air Compressor assembly shall be warranted free of defects in material and workmanship for a minimum period of 12 months without restrictions based on the purchase of special lubricants or maintenance kits. Compressor pumps shall be warranted for 5 years.
2. Refrigerated Dryer shall be warranted free of defects in material and workmanship for a minimum period of 2 years. Heat exchangers shall be warranted for 5 years.
3. The Contractor shall guarantee the work and installation against any defect in material and workmanship for a period of (1) year after final acceptance of work, unless noted otherwise in this section. Contractor shall replace any defective work covered by this guarantee immediately when notified at no expense to the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. All equipment shall be installed plumb and level, firmly anchored in locations indicated and in accordance with the equipment manufacturer's recommendations.

B. All equipment shall be installed with adequate clearance provided for routine maintenance and servicing.

C. Examine roughing-in for piping systems to verify actual locations of piping connections before air compressor installation.

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

E. Electrical Wiring: Verify that electrical wiring installation is acceptable to equipment Installer.

3.2 EQUIPMENT INSTALLATION

A. Equipment Mounting: Install air compressors on inertia base using vibration isolator pads.

B. Install refrigerated dryers anchored to concrete pad.

C. Install the following devices on compressed air-equipment:

1. Thermometer, Pressure Gage, and Safety Valve: Install on each compressed-air receiver.

2. Pressure Regulators: Install downstream from air compressors.

3. Automatic Drain Valves: Install on aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

4. Oil Removal Filter: Install downstream from air dryers.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to allow service and maintenance.

C. Connect piping to air compressors. Install valves that are same size as piping connected to air compressors. Reduce piping only at compressor.

D. Install electrical connections for power, controls, and devices.

E. Ground equipment according to Division 26 requirements.

F. Connect wiring according to Division 26 requirements.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative for one (1) four (4) hour period to train Owner's maintenance personnel to adjust, operate, and maintain air compressors.

END OF SECTION 22 27 10

SECTION 22 27 20
LABORATORY VACUUM PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

C. See Specification Section 22 03 20 "Equipment and System Start-Up" for start-up and verification testing requirements.

1.2 SCOPE

A. This Section specifies laboratory vacuum source equipment and accessories and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. Installation shall comply with the OBC - Pressure Piping Systems Code including obtaining a permit and inspection as required.

B. Electrical Control systems and Alarms shall be UL listed as assemblies with label affixed.

C. Vacuum system controls are to be wired in accordance with NEC.

1.4 QUALITY ASSURANCE

A. Installing contractor shall have at least 3 years successful installation experience on projects with vacuum systems work similar to that required for this project.

B. All installers must be certified by a qualified certification center. Installation and certification shall comply with ANSI/IAMPO/ASSE Series 6000.

C. The vacuum pump manufacturer shall provide factory authorized representatives to review installation and perform initial start up of system.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide laboratory gas system components as manufactured by one of the following:

1. Quincy
2. AirTech
3. Others, as approved Equal by the Engineer.

2.2 GENERAL

A. Provide factory-assembled, wired, piped, and tested; electric motor driven, air cooled; continuous duty vacuum pumps and receivers as scheduled and here in specified.

B. Provide a complete vacuum source, as specified and scheduled on the drawings.

C. Furnish complete plant consisting of pumps, receiver and controls capable of providing the scheduled capacity with one pump out of service.

D. System shall be completely factory assembled, requiring only interconnection between modules on site. Systems requiring site assembly other than interconnection are not acceptable (removal of components for shipping is permitted).

E. Each pump will be direct or close coupled to a NEMA rated High Efficiency TEFC motor with a service factor of 1.15.

F. Each pump will include inlet and outlet flex connectors.

2.3 RECIEVER TANK

A. Receivers shall be of steel tank constructed according to ASME Boiler and Pressure Vessel Code, Section VIII, Division 1; bearing appropriate code symbols.

1. Interior Finish: Shall include corrosion-resistant coating.

2. Accessories: Shall include vacuum relief valve, vacuum gauge, and drain.

B. Mounting Frame: Fabricate base and attachment to pressure vessel with reinforcement strong enough to resist packaged equipment movement during a seismic event when base is anchored to building structure.

2.4 PUMPS

A. Pumps shall be direct driven, rotary vane oil-flooded.

B. Pumps shall be capable of operating continuous duty at 28.4 inches mercury at sea level.

C. Pumps shall be air cooled

D. Each pump shall be furnished with the following:

1. 5 micron inlet air filter

2. Vacuum relief valve

3. Flexible connector and isolation valve

4. High discharge temperature sensor

5. Oil drain valve and oil sight glass

6. Vibration isolators

2.5 PUMP MOTORS

A. Compressor motors shall be a NEMA rated, C-face, TEFC with 1.15 service factor.

2.6 VIBRATION ISOLATION

A. Furnish each pump factory mounted on vibration isolators, and all intake and discharge connections to each pump shall be made with flexible pipe connectors.

B. If pumps are not individually isolated, the contractor shall furnish an inertia base sized for the entire system and shall field install system on base at this contractor's expense.

2.7 CONTROLS

A. Control Panels: Include automatic control station with load control and protection functions. Comply NEMA ICS 2 and UL 508.

1. Enclosure: Provide NEMA ICS 6, type 12 control panel unless otherwise indicated.
2. Motor Control: Shall be full voltage, combination magnetic type with undervoltage release feature and motor circuit protector type disconnecting means and short circuit protective device.
3. Control Voltage: Shall be 120V AC or less, using integral control power transformer.
4. Motor Overload Protection: Overload relay on each phase.
5. Starting Devices: Provide hand off automatic selector switch in cover of control panel, plus pilot device for automatic control.
6. Provide automatic control switches to alternate lead-lag vacuum pumps for duplex vacuum pumps.
7. Instrumentation shall include vacuum pump inlet and receiver vacuum gauges, hour meter, vacuum pump discharge-air and coolant temperature gauges, and control transformer.
8. Provide alarm signal device for connection to alarm system to indicate when backup vacuum pump is operating.

B. Programmable Logic Controllers (PLC) will be used to implement operating logic. PLC has integral memory and EPROM backup. PLC shall control the automatic alternation of the vacuum pumps with provisions for simultaneous operation if required, and automatic activation of reserve unit if required. A lag alarm on control cabinet and contacts for the master alarm will be provided.

C. The complete control system and all electrical components shall be NEMA 12 and UL labeled.

D. The control system shall provide:

1. Full voltage motor starters with overload protection.
2. 120 volt control circuit transformers.
3. Visual and audible reserve unit alarm with isolated contacts for remote alarms and audio cancel.
4. Control cabinet shall have lighted HOA selector switches.
5. Panel mounted vacuum gauge.

E. Provide with integral BacNet communication port and all necessary software to facilitate direct communication through a native BacNet network

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Install laboratory vacuum source systems in accordance with the drawings, specifications and manufacturer's instructions as stated within this document and all applicable federal, state and local standards and codes.

B. Install source equipment level and plumb, parallel, and perpendicular to other building systems and components in exposed interior spaces unless otherwise indicated.

C. Install source equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

E. Install the following devices on laboratory vacuum source equipment:

1. Pressure Gauge: Install on each receiver.

2. Drain Valves: Install on receivers. Discharge condensate over nearest floor drain.

F. Install vacuum source equipment on concrete bases. Units shall be anchored to concrete bases. Maintain manufacturers' recommended clearances. Orient equipment so controls and devices are accessible for servicing.

3.2 CONNECTIONS

A. Install piping adjacent to equipment to allow service and maintenance.

B. Connect vacuum piping to laboratory vacuum source equipment, accessories, and specialties with shutoff valve and union or flanged connection.

3.3 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

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

C. Tests and Inspections:

1. Vacuum Equipment Testing Coordination: Perform tests, inspections, verifications, and certification of vacuum equipment concurrently with tests, inspections, and certification of vacuum equipment and piping systems.

2. Replace damaged and malfunctioning controls and equipment.

3. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:

a. Inspections performed.

b. Procedures, materials, and gases used.

c. Test methods used.

d. Results of tests.

D. Components will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.4 EQUIPMENT ALARM INTERFACE

A. Alarms shall be interfaced with the building automation system.

3.5 STARTUP SERVICE

A. Engage a factory authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

2. Check for lubricating oil in lubricated type equipment.

3. Check belt drives for proper tension.
4. Verify that inlet piping is clear.
5. Check for equipment vibration control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
6. Drain receiver tanks.
7. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
8. Test and adjust controls and safeties.

3.6 DEMONSTRATION AND TRAINING

A. Engage a factory authorized service representative to train Owner's maintenance personnel to adjust, operate, maintain vacuum pumps.

END OF SECTION 22 27 20

SECTION 22 30 40
ACID WASTE SUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes the materials and installation requirements for grease interceptors utilized to store decontamination run-off waste.

B. Furnish equipment, materials, labor and supervision necessary to provide and install grease interceptors.

1.3 CODES AND STANDARDS

A. All plumbing systems shall comply with the latest edition of PDI Seal of Approval, the Local Plumbing Code, and all requirements of the local authority having jurisdiction.

B. Plumbing systems shall comply with ANSI, ASPE, ASSE, ASTM, CSA, NSF, and AWWA requirements.

1.4 SUBMITTALS

A. Shop Drawings: Include product material composition, flow requirements, unit dimensional data, storage capacity, clearance requirements, options and accessories, location and size of each pipe connection, manhole, and manufacturer's installation recommendations.

B. Operations and Maintenance Manuals: Include final accepted shop drawings.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Sewer Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sewer services according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of service.

2. Do not proceed with interruption of sewer services without Owner's written permission.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:

1. MIFAB, Inc.

2. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

3. Tyler Pipe; Wade Div.

4. Watts Drainage Products Inc.

5. Striem

6. Zurn Plumbing Products Group

2.2 ACID NEUTRALIZING SUMP

A. Tank shall be polypropylene or HDPE with bolt down gasket lid, inlet and outlet piping, vent, flanged connections.

B. Provide access to grade, using a 5'-0" diameter concrete or corrugated metal collar with a cast iron frame and lid in a 6 inch thick reinforced concrete cover, 4 inches above finish grade.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Acid Neutralizing Sump

1. Set basin on a 6 inch concrete slab, with the diameter the same as the outside diameter of the collar.
2. Provide stone around the basin, to just below the lid.
3. The access lid shall allow the removal of the basin lid. Size accordingly.
4. The lid and frame shall be set in a 6 inch concrete lid, 12 inches in diameter larger than the collar.
5. Fill the sump water and the required amount of limestone chip, with size as recommended by the manufacturer.
6. Piping connections to the tank shall be flanged.
7. The sump shall be located on the exterior of the building, 10'-0" minimum distance from the building.
8. Do not locate the interceptor in a drive area without providing adequate support over the tank.
9. Vent the acid sump into the building, up through the roof as shown on the drawings.

3.2 DELIVERY, STORAGE, HANDLING

A. Store underground acid waste sumps on site or off site to avoid damage due to construction activity and weather.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other sections of this division. Drawings indicate general arrangement of piping, fittings, and specialties.

END OF SECTION 22 30 40

SECTION 22 40 11
WATER CLOSETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes water closets, materials, and installation requirements.

B. Extent of work required by this Section is indicated on drawings and schedules and by requirements of this Section.

C. Furnish equipment, materials, labor, and supervision as required for complete installation of plumbing fixtures as specified herein.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of plumbing fixtures of type, style and configuration required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 CODES AND STANDARDS

A. ANSI Standards: Comply with applicable ANSI standards pertaining to plumbing fixtures and systems.

B. PDI Compliance: Comply with standards established by PDI pertaining to plumbing fixture supports.

C. Federal Standards: Comply with applicable FS WW-P-541/-Series sections pertaining to plumbing fixtures.

D. Regulatory Requirements: Comply with requirements of the Americans with Disabilities Act (ADA) of 1990 with respect to plumbing fixture requirements for the physically handicapped; providing accessibility and usability for physically handicapped people.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide vitreous china fixtures as manufactured by one of the following:

1. American Standard
2. Crane
3. Eljer

4. Kohler
5. Sloan
6. Zurn One

2.2 GENERAL

A. Provide factory-fabricated fixtures of type, style and material indicated. For each type fixture, provide fixture manufacturer's standard trim, carrier, seats and valves as shown by their published product information and indicated in the plumbing fixtures schedule; either as designed and constructed or as recommended by manufacturer and as required for complete installation.

B. All fixtures of same type must be furnished by a single manufacturer.

C. Unless otherwise specified, comply with applicable Federal Specification WW-P-541/- series sections pertaining to plumbing fixtures, fittings, trim, metals and finishes. Comply with requirements of WW-P-541/- specification relative to quality of ware, glazing, enamel, and composition and finish of metals; even though some plumbing fixtures specified in this Section are not described in WW-P-541/-

D. Provide materials which have been selected for their surface flatness and smoothness. Exposed surfaces which exhibit pitting seam marks, roller marks, foundry sand holes, stains, discoloration or other surface imperfections on finished units are not acceptable.

E. Where fittings, trim and accessories are exposed or semi-exposed, provide bright chrome-plated or polished stainless steel units. Provide copper or brass where not exposed.

2.3 MATERIALS

A. Provide fixtures constructed of vitreous china with all visible surfaces glazed.

B. Finish shall be high quality, free from fire cracks, spots, blisters, pinholes and specks, glaze exposed surfaces and test for crazing resistance in accordance with ASTM C554.

C. Provide water closets either floor or wall mounted and either bottom or rear discharge, as indicated on the drawings

D. Fixture Bolt Caps: Provide manufacturer's standard exposed fixture bolt caps finished to match fixture finish.

2.4 FLUSH VALVES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide flush valves as manufactured by one of the following:

1. American Standard
2. Delaney
3. Kohler
4. Moen
5. Sloan
6. Zurn

B. Manual flush valves shall have brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts. Internal design shall include diaphragm operation.

C. Electronic Infrared Flush Valves

1. Flush valve shall be diaphragm operated with a polished chrome plated finish.

2. Furnish with multi-lobular infrared sensor, which shall detect both user presence and duration. Infrared sensor shall be range adjustable and also duration adjustable for field adjusting to avoid nuisance flushes.

3. Flush valve shall be furnished with angle stop valve with back check protection, vandal resistant control stop cover, vacuum breaker, flush tube cover with wall flange, and fixture spud escutcheon.

4. Unless indicated otherwise, sensors shall be battery operated, powered by four (4) AA batteries with a flashing "low battery" indicator light.

5. Where indicated on the drawings, furnish recessed mounted, hard wired 24 volt fixtures. Sensor and electronics shall be mounted in a 13" by 17" stainless steel wall box with vandal resistant torx style fasteners. Furnish with 120 volt to 24 volt power transformer.

D. Dual-Flush Electronic Infrared Flush Valves

1. Flush valve shall be diaphragm operated with a polished chrome plated finish.

2. Furnish with multi-lobular infrared sensor, which shall detect both user presence and duration. Infrared sensor shall be range adjustable and also duration adjustable for field adjusting to avoid nuisance flushes. Flush volume shall be adjusted based on duration of sensor activation. Long duration flush shall be maximum 1.6 gallons, and short duration flush shall be maximum of 1.1 gallons.

3. Flush valve shall be furnished with angle stop valve with back check protection, vandal resistant control stop cover, vacuum breaker, flush tube cover with wall flange, and fixture spud escutcheon.

4. Unless indicated otherwise, sensors shall be battery operated, powered by four (4) AA batteries with a flashing "low battery" indicator light.

E. Escutcheons

1. Chrome-plated sheet steel with friction slips.

2.5 SEATS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide water closet seats as manufactured by one of the following:

1. American Standard

2. Bemis

3. Beneke

4. Church

5. Kohler

6. Sloan

7. Olsonite

B. Materials

1. Seats shall be injection molded of high strength, impact, and chemical resistant plastic.

2. Bumpers shall be integrally molded into the seat.

3. Check hinges are to have stainless steel posts, washers, and nuts.

4. Color shall be white.

2.6 FIXTURE CARRIERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide fixture carriers as manufactured by one of the following:

1. JOSAM
2. J.R. Smith
3. Tyler Pipe (Wade)
4. Watts Drainage Products
5. Zurn

B. Materials

1. Provide cast iron supports for fixtures of either graphitic gray iron, ductile iron or malleable iron as indicated. Provide carriers and supports as required for proper fixture installation.
2. Type shall permit field adjustment to fit variations in construction.
3. Adjustable face plate and wall-mounted closet supports shall be securely bolted to floor.
4. Carriers shall be furnished at regular height or at ADA mounting height as scheduled on the drawings.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify all dimensions by field measurements. Verify that all plumbing fixtures may be installed in accordance with pertinent codes and regulations, the original design and the referenced standards.

B. Examine roughing-in work of potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Also examine floors and substrates and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping and other unsatisfactory conditions for installation of plumbing fixtures. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION REQUIREMENTS

A. Install all plumbing fixtures where shown on the drawings, at the indicated heights. Install in accordance with fixture manufacturer's written instructions, roughing-in drawings and with recognized industry practices.

B. Where required, install fixtures in compliance with the requirements of The Americans with Disabilities Act. For handicapped accessible water closets, mount flush valve handle on the access side of the fixture.

C. Install all fixture carriers and supports in accordance with manufacturers published instructions. Securely fasten carriers and supports to the building structure.

D. Install all fixtures square with wall, level and plumb. Secure all traps, stops and supplies to prevent any movement.

E. Install all stops, supplies, and escutcheons as required for a complete installation. Locate all fixture stops immediately below the fixture. Nipples between copper piping and fixtures stops shall be brass, not galvanized steel. Where exposed, nipples shall be chrome plated.

F. Seal space between plumbing fixtures and wall or floor with white silicone sealant to provide a watertight installation.

G. Protect installed plumbing fixtures from damaged until construction is completed and accepted by Owner. Remove protective covering when ready for use.

3.3 DELIVERY, STORAGE, HANDLING, PROTECTION

A. Store all fixtures and materials on site or off site to avoid damage due to construction activity and weather. Deliver plumbing fixtures individually wrapped in factory-fabricated containers.

B. Provide protective covering for installed fixtures and trim.

C. Handle plumbing fixtures carefully to prevent breakage, chipping and scoring fixture finish. Do not install damaged plumbing fixtures, replace and return damaged units to equipment manufacturer.

D. Do not allow use of fixtures for temporary facilities unless expressly approved in writing by Architect.

3.4 CONNECTIONS

A. Make final cold water connections and provide necessary piping, materials and fittings for a complete installation.

B. Make final drain and vent connections and provide necessary piping, materials and fittings for a complete installation.

3.5 CLEANING

A. Remove all fixture labels and clean all fixtures to remove stains.

3.6 TESTING AND ADJUSTING

A. Adjust all flush valves and other fixture water supplies to provide proper water flow.

B. Adjust electronic infrared sensor detection range and duration limits for proper fixture operation and to avoid nuisance activation.

END OF SECTION 22 40 11

SECTION 22 40 12
URINALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes urinals, including materials and installation requirements.

B. Extent of work required by this Section is indicated on drawings and schedules and by requirements of this Section.

C. Furnish equipment, materials, labor, and supervision as required for complete installation of plumbing fixtures as specified herein.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of urinals of type, style and configuration required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 CODES AND STANDARDS

A. ANSI Standards: Comply with applicable ANSI standards pertaining to plumbing fixtures and systems.

B. PDI Compliance: Comply with standards established by PDI pertaining to plumbing fixture supports.

C. Federal Standards: Comply with applicable FS WW-P-541/-Series sections pertaining to plumbing fixtures.

D. Regulatory Requirements: Comply with requirements of the Americans with Disabilities Act (ADA) of 1990 with respect to plumbing fixture requirements for the physically handicapped; providing accessibility and usability for physically handicapped people.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide vitreous china fixtures as manufactured by one of the following:

1. American Standard
2. Crane
3. Eljer

4. Kohler
5. Sloan
6. Zurn One

2.2 GENERAL

A. Provide factory-fabricated fixtures of type, style and material indicated. For each type fixture, provide fixture manufacturer's standard trim, carrier, and valves as shown by their published product information and indicated in the plumbing fixtures schedule; either as designed and constructed or as recommended by manufacturer and as required for complete installation.

B. All fixtures of same type must be furnished by a single manufacturer.

C. Unless otherwise specified, comply with applicable Federal Specification WW-P-541/- series sections pertaining to plumbing fixtures, fittings, trim, metals and finishes. Comply with requirements of WW-P-541/- specification relative to quality of ware, glazing, enamel, and composition and finish of metals; even though some plumbing fixtures specified in this Section are not described in WW-P-541/-

D. Provide materials which have been selected for their surface flatness and smoothness. Exposed surfaces which exhibit pitting seam marks, roller marks, foundry sand holes, stains, discoloration or other surface imperfections on finished units are not acceptable.

E. Where fittings, trim and accessories are exposed or semi-exposed, provide bright chrome-plated or polished stainless steel units. Provide copper or brass where not exposed.

2.3 MATERIALS

A. Provide fixtures constructed of vitreous china with all visible surfaces glazed.

B. Finish shall be high quality, free from fire cracks, spots, blisters, pinholes and specks, glaze exposed surfaces and test for crazing resistance in accordance with ASTM C554.

C. Provide urinals either floor or wall mounted, as indicated on the drawings

2.4 FLUSH VALVES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide flush valves as manufactured by one of the following:

1. American Standard
2. Delany
3. Kohler
4. Moen
5. Sloan
6. Zurn

B. Manual flush valves shall have brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts. Internal design shall include diaphragm operation.

C. Electronic Infrared Flush Valves

1. Flush valve shall be diaphragm operated with a polished chrome plated finish.
2. Furnish with multi-lobular infrared sensor, which shall detect both user presence and duration. Infrared sensor shall be range adjustable and also duration adjustable for field adjusting to avoid nuisance flushes.

3. Flush valve shall be furnished with angle stop valve with back check protection, vandal resistant control stop cover, vacuum breaker, flush tube cover with wall flange, and fixture spud escutcheon.

4. Unless indicated otherwise, sensors shall be battery operated, powered by four (4) AA batteries with a flashing "low battery" indicator light.

5. Where indicated on the drawings, furnish recessed mounted, hard wired 24 volt fixtures. Sensor and electronics shall be mounted in a 13" by 17" stainless steel wall box with vandal resistant torx style fasteners. Furnish with 120 volt to 24 volt power transformer.

2.5 FIXTURE CARRIERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide fixture carriers as manufactured by one of the following:

1. JOSAM
2. J.R. Smith
3. Tyler Pipe (Wade)
4. Watts Drainage Products
5. Zurn

B. Materials

1. Provide cast iron supports for fixtures of either graphitic gray iron, ductile iron or malleable iron as indicated. Provide carriers and supports as required for proper fixture installation.
2. Type shall permit field adjustment to fit variations in construction.
3. Adjustable face plate and wall-mounted urinal supports shall be securely bolted to the floor.
4. Carriers shall be furnished at regular height or at ADA mounting height as scheduled on the drawings.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify all dimensions by field measurements. Verify that all urinals may be installed in accordance with pertinent codes and regulations, the original design and the referenced standards.

B. Examine roughing-in work of potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Also examine floors and substrates and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping and other unsatisfactory conditions for installation of plumbing fixtures. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION

A. Install all plumbing fixtures where shown on the drawings, at the indicated heights. Install in accordance with fixture manufacturer's written instructions, roughing-in drawings and with recognized industry practices.

B. Where required, install fixtures in compliance with the requirements of The Americans with Disabilities Act. For handicapped accessible water closets, mount flush valve handle on the access side of the fixture.

C. Install all fixture carriers and supports in accordance with manufacturers published instructions. Securely fasten carriers and supports to the building structure.

D. Install all fixtures square with wall, level and plumb. Secure supplies to prevent any movement.

E. Install all escutcheons as required for a complete installation.

F. Seal space between plumbing fixtures and wall or floor with white silicone sealant to provide a watertight installation.

G. Protect installed plumbing fixtures from damaged until construction is completed and accepted by Owner. Remove protective covering when ready for use.

3.3 DELIVERY, STORAGE, HANDLING, PROTECTION

A. Store all fixtures and materials on site or off site to avoid damage due to construction activity and weather.

B. Deliver plumbing fixtures individually wrapped in factory-fabricated containers. Provide protective covering for installed fixtures and trim.

C. Handle plumbing fixtures carefully to prevent breakage, chipping and scoring fixture finish. Do not install damaged plumbing fixtures, replace and return damaged units to equipment manufacturer.

D. Do not allow use of fixtures for temporary facilities unless expressly approved in writing by Architect.

3.4 CONNECTIONS

A. Make final cold water connections and provide necessary piping, materials and fittings for a complete installation.

B. Make final drain and vent connections and provide necessary piping, materials and fittings for a complete installation.

3.5 CLEANING

A. Remove all fixture labels and clean all fixtures to remove stains.

3.6 TESTING AND ADJUSTING

A. Adjust all flush valves and other fixture water supplies to provide proper water flow.

B. Adjust electronic infrared sensor detection range and duration limits for proper fixture operation and to avoid nuisance activation.

END OF SECTION 22 40 12

SECTION 22 40 14
LAVATORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes lavatories, materials, and installation requirements.

B. Extent of plumbing fixtures work required by this Section is indicated on drawings and schedules and by requirements of this Section.

C. Furnish equipment, materials, labor, and supervision as required for complete installation of plumbing fixtures as specified herein.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of plumbing fixtures of type, style and configuration required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 CODES AND STANDARDS

A. ANSI Standards: Comply with applicable ANSI standards pertaining to plumbing fixtures and systems.

B. PDI Compliance: Comply with standards established by PDI pertaining to plumbing fixture supports.

C. Federal Standards: Comply with applicable FS WW-P-541/-Series sections pertaining to plumbing fixtures.

D. Regulatory Requirements: Comply with requirements of the Americans with Disabilities Act (ADA) of 1990 with respect to plumbing fixture requirements for the physically handicapped; providing accessibility and usability for physically handicapped people.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide vitreous china fixtures as manufactured by one of the following:

1. American Standard
2. Crane
3. Eljer

4. Sloan
5. Kohler

2.2 GENERAL

A. Provide factory-fabricated fixtures of type, style and material indicated. For each type fixture, provide fixture manufacturer's standard trim and valves as shown by their published product information and indicated in the plumbing fixtures schedule; either as designed and constructed or as recommended by manufacturer and as required for complete installation.

B. All fixtures of same type must be furnished by a single manufacturer.

C. Where type is not otherwise indicated, provide fixtures complying with governing regulations.

D. Unless otherwise specified, comply with applicable Federal Specification WW-P-541/- series sections pertaining to plumbing fixtures, fittings, trim, metals and finishes. Comply with requirements of WW-P-541/- specification relative to quality of ware, glazing, enamel, and composition and finish of metals; even though some plumbing fixtures specified in this Section are not described in WW-P-541/-

E. Where fittings, trim and accessories are exposed or semi-exposed, provide bright chrome-plated or polished stainless steel units. Provide copper or brass where not exposed.

2.3 MATERIALS

A. Provide fixtures constructed of vitreous china with all visible surfaces glazed.

B. Finish shall be high quality, free from fire cracks, spots, blisters, pinholes and specks, glaze exposed surfaces and test for crazing resistance in accordance with ASTM C554.

C. Provide lavatories either wall mounted (with a carrier), under-counter mount or drop-in countertop mounted, as indicated on the drawings and schedules.

2.4 FAUCETS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide faucets as manufactured by one of the following:

1. American Standard
2. Chicago Faucet Company
3. Delta Commercial
4. Kohler
5. Moen Commercial
6. T+S Brass
7. Zurn Aquaspec

B. General:

1. Furnish faucets compatible with associated fixture, matching quantity and spacing of anchorages and supply piping with pre-fabricated fixture penetrations.
2. Provide faucet outlets of types approved by the local Health Department.
3. Note – Aerators in health care facilities shall be laminar flow "Careguard" as manufactured by Neoperl.

C. Manual Faucets

1. Provide faucets with polished chrome plated finished unless noted otherwise.
2. Handles shall be ADA compliant when specified.

D. Electronic Infrared Faucets

1. Provide faucets with polished chrome plated finished unless noted otherwise.

2. Furnish with multi-lobular infrared sensor, which shall detect both user presence and duration. Infrared sensor shall be range adjustable and also duration adjustable for field adjusting to avoid nuisance operations.

3. Provide flow restricting orifice in faucets where restraint of flow is required.

E. Escutcheons

1. Chrome-plated sheet steel with friction slips.

F. Comply with additional fixture requirements contained in fixture schedule on drawings.

2.5 FIXTURE CARRIERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide fixture carriers as manufactured by one of the following:

1. JOSAM

2. J.R. Smith

3. Tyler Pipe (Wade)

4. Watts Drainage Products

5. Zurn

B. Materials

1. Provide cast iron supports for wall-hung fixtures of either graphitic gray iron, ductile iron or malleable iron as indicated. Provide carriers and supports as required for proper fixture installation.

2. Type shall permit field adjustment to fit variations in construction.

3. Wall mounted lavatories shall have adjustable concealed arms with support carrier securely bolted to floor.

4. Carriers shall be furnished at regular height or at ADA mounting height as scheduled on the drawings.

2.6 FIXTURES, SUPPLIES, STOPS AND TRAPS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products as manufactured by one of the following:

1. Brasscraft

2. Engineered Brass Company

3. McGuire Manufacturing Company, Inc.

B. Materials

1. All components shall be chrome plated brass unless noted otherwise.

a. Stops shall be 1/4 turn brass ball volume, straight or angle type as required by the installation, with loose key, metal stem and washer cup with set screw washer retainer. Furnish with escutcheon.

b. Traps shall be 17 gauge chrome plated brass with clean-out plug. Furnish with slip nuts, wall bend and escutcheon.

c. Supplies shall be flexible chrome plated copper.

2.7 ADA INSULATION KITS

A. See Section 22 11 10.

B. Materials

1. Insulation kits shall be a minimum of 1/8" thick molded closed cell vinyl construction with PVC satin white cover. Insulation material shall be anti-microbial/ anti fugal. Provide kit with removable valve access caps.

2. Units shall be barrier-free, and shall be installed per ADA requirements and shall comply with ICC/ANSI A 117.1.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify all dimensions by field measurements. Verify that all plumbing fixtures may be installed in accordance with pertinent codes and regulations, the original design and the referenced standards.

B. Examine roughing-in work of potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Also examine floors and substrates and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping and other unsatisfactory conditions for installation of plumbing fixtures. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION

A. Install all plumbing fixtures where shown on the drawings, at the indicated heights. Install in accordance with fixture manufacturer's written instructions, roughing-in drawings and with recognized industry practices.

B. Where required, install fixtures in compliance with the requirements of The Americans with Disabilities Act. Provide ADA insulation kits on waste and water supply piping where required for compliance.

C. Install all fixture carriers and supports in accordance with manufacturers published instructions. Securely fasten carriers and supports to the building structure.

D. Install all fixtures square with wall, level and plumb. Secure all traps, stops and supplies to prevent any movement.

E. Install all stops, supplies, traps and escutcheons as required for a complete installation. Locate all fixture stops immediately below the fixture. Nipples between copper piping and fixtures stops shall be brass, not galvanized steel. Where exposed, nipples shall be chrome plated.

F. Seal space between plumbing fixtures and wall with white silicone sealant to provide a watertight installation.

G. Protect installed plumbing fixtures from damaged until construction is completed and accepted by Owner. Remove protective covering when ready for use.

3.3 DELIVERY, STORAGE, HANDLING, PROTECTION

A. Store all fixtures and materials on site or off site to avoid damage due to construction activity and weather.

B. Deliver plumbing fixtures individually wrapped in factory-fabricated containers. Provide protective covering for installed fixtures and trim.

C. Handle plumbing fixtures carefully to prevent breakage, chipping and scoring fixture finish. Do not install damaged plumbing fixtures, replace and return damaged units to equipment manufacturer.

D. Do not allow use of fixtures for temporary facilities unless expressly approved in writing by Architect.

3.4 CONNECTIONS

A. Make final cold and hot water connections and provide necessary piping, materials and fittings for a complete installation.

B. Make final drain and vent connections and provide necessary piping, materials and fittings for a complete installation.

3.5 CLEANING

A. Remove all fixture labels and clean all fixtures to remove stains.

3.6 TESTING AND ADJUSTING

A. Adjust all faucets and other fixture water supplies to provide proper water flow.

B. Adjust electronic infrared sensor detection range and duration limits for proper fixture operation and to avoid nuisance activation.

END OF SECTION 22 40 14

SECTION 22 40 20
STAINLESS STEEL SINKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes stainless steel sinks, materials, and installation requirements.

B. Extent of plumbing fixtures work required by this Section is indicated on drawings and schedules and by requirements of this Section.

C. Furnish equipment, materials, labor, and supervision as required for complete installation of plumbing fixtures as specified herein.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of plumbing fixtures of type, style and configuration required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 CODES AND STANDARDS

A. ANSI Standards: Comply with applicable ANSI standards pertaining to plumbing fixtures and systems.

B. PDI Compliance: Comply with standards established by PDI pertaining to plumbing fixture supports.

C. Federal Standards: Comply with applicable FS WW-P-541/-Series sections pertaining to plumbing fixtures.

D. Regulatory Requirements: Comply with requirements of the Americans with Disabilities Act (ADA) of 1990 with respect to plumbing fixture requirements for the physically handicapped; providing accessibility and usability for physically handicapped people.

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

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide stainless steel sinks as manufactured by one of the following:

1. Elkay
2. Just

2.2 GENERAL

A. Provide factory-fabricated fixtures of type, style and material indicated.

B. For each type fixture, provide fixture manufacturer's standard trim as shown by their published product information and indicated in the plumbing fixtures schedule; either as designed and constructed or as recommended by manufacturer and as required for complete installation.

C. Where more than one type is indicated, selection is Installer's option; but, all fixtures of same type must be furnished by single manufacturer.

2.3 SINKS

A. Provide materials which have been selected for their surface flatness and smoothness. Exposed surfaces which exhibit pitting seam marks, roller marks, stains, discoloration or other surface imperfections on finished units are not acceptable.

B. Sinks shall be minimum18 gauge stainless steel ASTM A167, Type 302/304, hard workable temper, under counter mount or self rimming, and fully undercoated for sound proofing.

C. Stainless steel sinks shall have a No. 4 satin finish directional polished in exposed surfaces, unless noted otherwise.

2.4 ACCESSORIES

A. Water Outlets: At locations where water is supplied (by manual, automatic or remote control), provide commercial quality faucets, valves or dispensing devices of type and size indicated and as required to operate as indicated. Include manual shut-off valves and connecting stem pipes to permit outlet servicing without shut-down of water supply piping systems. Provide flow restricting orifice in faucets where restraint of flow is required.

B. P-Traps: Include removable P-traps (with clean out plug) where drains are indicated for direct connection to drainage system.

C. Comply with additional fixture requirements contained in fixture schedule on drawings.

2.5 FAUCETS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide faucets as manufactured by one of the following:

1. American Standard
2. Chicago Faucet Company
3. Delta Commercial
4. Kohler
5. Moen Commercial
6. T&S Brass
7. Zurn Aquaspec

B. General:

1. Furnish faucets compatible with associated fixture, matching quantity and spacing of anchorages and supply piping with pre-fabricated fixture penetrations.
2. Provide faucet outlets of types approved by the local Health Department.
3. Note – Aerators in health care facilities shall be laminar flow "Careguard" as manufactured by Neoperl.

C. Manual Faucets

1. Provide faucets with polished chrome plated finished unless noted otherwise.

2. Handles shall be ADA compliant when specified.

D. Electronic Infrared Faucets

1. Provide faucets with polished chrome plated finished unless noted otherwise.

2. Furnish with multi-lobular infrared sensor, which shall detect both user presence and duration. Infrared sensor shall be range adjustable and also duration adjustable for field adjusting to avoid nuisance operations.

3. Provide faucet outlets of types scheduled and approved by the local Health department.

2.6 FIXTURES, SUPPLIES, STOP AND TRAPS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products as manufactured by one of the following:

1. Brasscraft

2. Engineered Brass Company

3. McGuire Manufacturing Company, Inc.

B. Materials

1. All components shall be chrome plated brass unless noted otherwise.

a. Stops shall be ¼ turn brass ball volume, straight or angle type as required by the installation, with loose key, metal stem and washer cu[with set screw washer retainer. Furnish with escutcheon.

b. Traps shall be 17 gauge chrome plated brass with clean-out plug. Furnish with slip nuts, wall bend and escutcheon.

c. Supplies shall be flexible chrome plated copper.

2.7 ADA INSULATION KITS

A. See Section 22 11 10.

B. Materials

1. Insulation kits shall be a minimum of 1/8" thick molded closed cell vinyl construction with PVC satin white cover. Insulation material shall be antimicrobial/anti fugal. Provide kit with removable valve access caps.

2. Units shall be barrier-free, and shall be installed per ADA requirements and shall comply with ICC/ANSI A 117.1.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify all dimensions by field measurements. Verify that all plumbing fixtures may be installed in accordance with pertinent codes and regulations, the original design and the referenced standards.

B. Examine roughing-in work of potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Also examine floors and substrates and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping and other unsatisfactory conditions for installation of plumbing fixtures. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION REQUIREMENTS

A. Install all plumbing fixtures where shown on the drawings, at the indicated heights. Install in accordance with fixture manufacturer's written instructions, roughing-in drawings and with recognized industry practices.

B. Where required, install fixtures in compliance with the requirements of The Americans with Disabilities Act. For handicapped accessible water closets, mount flush valve handle on the access side of the fixture.

C. Install all fixture supports in accordance with manufacturers published instructions. Securely fasten carriers and supports to the building structure.

D. Install all fixtures square with wall, level and plumb. Secure all traps, stops and supplies to prevent any movement.

E. Install all stops, supplies, traps and escutcheons as required for a complete installation. Locate all fixture stops immediately below the fixture. Nipples between copper piping and fixtures stops shall be brass, not galvanized steel. Where exposed, nipples shall be chrome plated.

F. Seal space between countertop and fixture rim with silicone sealant to provide a watertight installation.

G. Protect installed plumbing fixtures from damaged until construction is completed and accepted by Owner. Remove protective covering when ready for use.

3.3 DELIVERY, STORAGE, HANDLING, PROTECTION

A. Store all fixtures and materials on site or off site to avoid damage due to construction activity and weather.

B. Provide protective covering for installed fixtures and trim.

C. Do not allow use of fixtures for temporary facilities unless expressly approved in writing by Architect.

3.4 CONNECTIONS

A. Make final cold and hot water connections and provide necessary piping, materials and fittings for a complete installation.

B. Make final drain and vent connections and provide necessary piping, materials and fittings for a complete installation.

3.5 CLEANING

A. Remove all fixture labels and clean all fixtures to remove stains.

3.6 STARTUP, TESTING AND ADJUSTING

A. Adjust all fixture water supplies to provide proper water flow.

B. Adjust electronic infrared sensor detection range and duration limits for proper fixture operation and to avoid nuisance activation.

END OF SECTION 22 40 20

SECTION 22 40 30
LAUNDRY SINKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes laundry sinks, materials, and installation requirements.

B. Extent of plumbing fixtures work required by this Section is indicated on drawings and schedules and by requirements of this Section.

C. Furnish equipment, materials, labor, and supervision as required for complete installation of plumbing fixtures as specified herein.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of plumbing fixtures of type, style and configuration required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 CODES AND STANDARDS

A. ANSI Standards: Comply with applicable ANSI standards pertaining to plumbing fixtures and systems.

B. PDI Compliance: Comply with standards established by PDI pertaining to plumbing fixture supports.

C. Federal Standards: Comply with applicable FS WW-P-541/-Series sections pertaining to plumbing fixtures.

D. Regulatory Requirements: Comply with requirements of the Americans with Disabilities Act (ADA) of 1990 with respect to plumbing fixture requirements for the physically handicapped; providing accessibility and usability for physically handicapped people.

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

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver plumbing fixtures individually wrapped in factory-fabricated containers.

B. Handle plumbing fixtures carefully to prevent breakage, chipping and scoring fixture finish. Do not install damaged plumbing fixtures, replace and return damaged units to equipment manufacturer.

1.6 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide laundry sinks as manufactured by one of the following:

1. Mustee
2. Fiat

2.2 GENERAL

A. Provide factory-fabricated fixtures of type, style and material indicated.

B. For each type fixture, provide fixture manufacturer's standard trim as shown by their published product information and indicated in the plumbing fixtures schedule; either as designed and constructed or as recommended by manufacturer and as required for complete installation.

C. Where more than one type is indicated, selection is Installer's option; but, all fixtures of same type must be furnished by single manufacturer.

D. Where fittings, trim and accessories are exposed or semi-exposed, provide bright chrome-plated or polished stainless steel units. Provide copper or brass where not exposed.

2.3 MATERIALS

A. Furnish single tub or double tub, as scheduled on the drawings.

B. Construct of molded-stone

C. Furnish either wall mounted or floor mounted, as scheduled on the drawings. Floor mounted units shall be furnished with integral steel angle powder coated legs at each corner

D. Coordinate faucet openings with scheduled faucet and provide tub with either 4" or 8" on center knock-outs.

2.4 ACCESSORIES

A. Water Outlets: At locations where water is supplied (by manual, automatic or remote control), provide commercial quality faucets, valves or dispensing devices of type and size indicated and as required to operate as indicated. Include manual shut-off valves and connecting stem pipes to permit outlet servicing without shut-down of water supply piping systems. Provide flow restricting orifice in faucets where restraint of flow is required.

B. P-Traps: Include removable P-traps (with clean out plug) where drains are indicated for direct connection to drainage system.

C. Aerators: Provide aerators as permitted by local health department. Note: aerators are not approved for use in Health care facilities.

D. Comply with additional fixture requirements contained in fixture schedule on drawings.

2.5 FAUCETS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide faucets as manufactured by one of the following:

1. Chicago Faucet Company
2. Delta Commercial
3. Moen Commercial
4. T&S Brass
5. Zurn Aquaspec

B. General

1. Provide faucets with polished chrome plated finished unless noted otherwise.
2. Handles shall be ADA compliant when specified.
3. Provide faucet outlets of types approved by the local Health Department.

2.6 FIXTURES, SUPPLIES, STOPS AND TRAPS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products as manufactured by one of the following:

1. Brasscraft
2. Engineered Brass Company
3. McGuire Manufacturing Company, Inc.

B. Materials

1. All components shall be chrome plated brass unless noted otherwise.
   a. Stops shall be ¼ turn brass ball volume, straight or angle type as required by the installation, with loose key, metal stem and washer cup with set screw washer retainer. Furnish with escutcheon.
   b. Traps shall be 17 gauge chrome plated brass with clean-out plug. Furnish with slip nuts, wall bend and escutcheon.
   c. Suppliers shall be flexible chrome plated copper.

2.7 ADA INSULATION KITS

A. See Section 22 11 10.

B. Materials

1. Insulation kits shall be a minimum of 1/8" thick molded closed cell vinyl construction with PVC satin white cover. Insulation material shall be antimicrobial/anti fugal. Provide kit with removable valve access caps.
2. Units shall be barrier-free, and shall be installed per ADA requirements and shall comply with ICC/ANSI A 117.1.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify all dimensions by field measurements. Verify that all plumbing fixtures may be installed in accordance with pertinent codes and regulations, the original design and the referenced standards.

B. Examine roughing-in work of potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Also examine floors and substrates and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping and other unsatisfactory conditions for installation of plumbing fixtures. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION REQUIREMENTS

A. Install all plumbing fixtures where shown on the drawings, at the indicated heights. Install in accordance with fixture manufacturer's written instructions, roughing-in drawings and with recognized industry practices.

B. Where required, install fixtures in compliance with the requirements of The Americans with Disabilities Act. For handicapped accessible water closets, mount flush valve handle on the access side of the fixture.

C. Install all fixture supports in accordance with manufacturers published instructions. Securely fasten carriers and supports to the building structure.

D. Install all fixtures square with wall, level and plumb. Secure all traps, stops and supplies to prevent any movement.

E. Install all stops, supplies, traps and escutcheons as required for a complete installation. Locate all fixture stops immediately below the fixture. Nipples between copper piping and fixtures stops shall be brass, not galvanized steel. Where exposed, nipples shall be chrome plated.

F. Protect installed plumbing fixtures from damaged until construction is completed and accepted by Owner. Remove protective covering when ready for use.

3.3 DELIVERY, STORAGE, HANDLING, PROTECTION

A. Store all fixtures and materials on site or off site to avoid damage due to construction activity and weather.

B. Provide protective covering for installed fixtures and trim.

C. Do not allow use of fixtures for temporary facilities unless expressly approved in writing by Architect.

3.4 CONNECTIONS

A. Make final cold and hot water connections and provide necessary piping, materials and fittings for a complete installation.

B. Make final drain and vent connections and provide necessary piping, materials and fittings for a complete installation.

3.5 CLEANING

A. Remove all fixture labels and clean all fixtures to remove stains.

END OF SECTION 22 40 30

SECTION 22 40 32
MOP BASINS (TERRAZZO)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes mop basins, materials, and installation requirements.

B. Extent of plumbing fixtures work required by this Section is indicated on drawings and schedules and by requirements of this Section.

C. Furnish equipment, materials, labor, and supervision as required for complete installation of plumbing fixtures as specified herein.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of plumbing fixtures of type, style and configuration required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 CODES AND STANDARDS

A. ANSI Standards: Comply with applicable ANSI standards pertaining to plumbing fixtures and systems.

B. PDI Compliance: Comply with standards established by PDI pertaining to plumbing fixture supports.

C. Federal Standards: Comply with applicable FS WW-P-541/-Series sections pertaining to plumbing fixtures.

D. Regulatory Requirements: Comply with requirements of the Americans with Disabilities Act (ADA) of 1990 with respect to plumbing fixture requirements for the physically handicapped; providing accessibility and usability for physically handicapped people.

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

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide terrazzo mop basins as manufactured by one of the following:

1. Fiat

2. Florestone Products

3. Kohler
4. Mustee
5. Proflo
6. Stern Williams
7. Swanstone
8. Terrazzoware
9. White Stone Co.

2.2 GENERAL

A. For each fixture, provide fixture manufacturer's standard trim, accessories and valves as shown by their published product information and indicated in the plumbing fixtures schedule; either as designed and constructed or as recommended by manufacturer and as required for complete installation.

B. Where more than one type is indicated, selection is Installer's option; but, all fixtures of same type must be furnished by single manufacturer.

C. Unless otherwise specified, comply with applicable Federal Specification WW-P-541/-Series sections pertaining to plumbing fixtures, fittings, trim, metals and finishes. Comply with requirements of WW-P-541/specification relative to quality of ware, glazing, enamel, composition and finish of metals, air gaps and vacuum breakers, even though some plumbing fixtures specified in this Section are not described in WW-P-541/-.

D. Provide materials which have been selected for their surface flatness and smoothness. Exposed surfaces which exhibit pitting seam marks, roller marks, stains, discoloration or other surface imperfections on finished units are not acceptable.

2.3 MATERIALS

A. Furnish terrazzo mop basins as indicated on the drawings.

B. Terrazzo shall be high quality and free from defects, with glaze on exposed surfaces and stain resistant. Terrazzo composition compression strength shall be minimum 3000 psi, with surface ground and polished and casting pits and holes filled and polished smooth. Reinforce units with minimum 16 ga wire.

C. Drain shall be integral cast brass with stainless steel grid.

D. Furnish with accessories as indicated on the drawings.

2.4 FAUCETS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide faucets as manufactured by one of the following:

1. American Standard
2. Chicago Faucet Company
3. Delta Commercial
4. Kohler
5. Moen Commercial

B. Manual Faucets

1. Provide faucets with polished chrome plated finished unless noted otherwise.
2. Handles shall be ADA compliant when specified.

3. Provide faucet outlets of types approved by the local Health Department.

4. Provide faucet with integral check stops.

2.5 ACCESSORIES

A. Where fittings, trim and accessories are exposed or semi-exposed, provide bright chrome-plated or polished stainless steel units. Provide copper or brass where not exposed.

B. Water Outlets: At locations where water is supplied, provide commercial quality faucets, valves or dispensing devices of type and size indicated and as required to operate as indicated. Include manual shut-off valves and connecting stem pipes to permit outlet servicing without shut-down of water supply piping systems. Provide check valves on the mop-basin-side of each shutoff valve. Provide flow restricting orifice in faucets where restraint of flow is required.

C. Vacuum Breakers: Provide with flush valves where required by governing regulations, including locations where water outlets are equipped for hose attachment. Vacuum breakers shall be atmospheric or pressure type as required by piping arrangement and equipment being served. Type shall determine mounting height.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify all dimensions by field measurements. Verify that all plumbing fixtures may be installed in accordance with pertinent codes and regulations, the original design and the referenced standards.

B. Examine roughing-in work of potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Also examine floors and substrates and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping and other unsatisfactory conditions for installation of plumbing fixtures. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION REQUIREMENTS

A. Install all plumbing fixtures where shown on the drawings. Install in accordance with fixture manufacturer's written instructions, roughing-in drawings and with recognized industry practices.

B. Install all fixture supports in accordance with manufacturers published instructions. Securely fasten carriers and supports to the building structure.

C. Install all fixtures square with wall, level and plumb. Secure all supplies to prevent any movement.

D. Install all supplies and escutcheons as required for a complete installation.

E. Protect installed plumbing fixtures from damaged until construction is completed and accepted by Owner. Remove protective covering when ready for use.

3.3 DELIVERY, STORAGE, HANDLING, PROTECTION

A. Store all fixtures and materials on site or off site to avoid damage due to construction activity and weather.

B. Provide protective covering for installed fixtures and trim.

C. Do not allow use of fixtures for temporary facilities unless expressly approved in writing by Architect.

3.4 CONNECTIONS

A. Make final cold and hot water connections and provide necessary piping, materials and fittings for a complete installation.

B. Make final drain and vent connections and provide necessary piping, materials and fittings for a complete installation.

3.5 CLEANING

A. Remove all fixture labels and clean all fixtures to remove stains.

END OF SECTION 22 40 32

SECTION 22 40 43

GAS TURRETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes materials, and installation requirements for gas turrets.

B. Extent of plumbing work required by this Section is indicated on drawings and schedules and by requirements of this Section.

C. Furnish equipment, materials, labor, and supervision as required for complete installation of plumbing fixtures as specified herein.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of gas turrets of type, style and configuration required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 CODES AND STANDARDS

A. ANSI Standards: Comply with applicable ANSI standards pertaining to plumbing fixtures and systems.

B. Federal Standards: Comply with applicable FS WW-P-541/-Series sections pertaining to plumbing fixtures.

C. Regulatory Requirements: Comply with requirements of the Americans with Disabilities Act (ADA) of 1990 with respect to plumbing fixture requirements for the physically handicapped; providing accessibility and usability for physically handicapped people.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver plumbing fixtures individually wrapped in factory-fabricated containers.

B. Handle plumbing fixtures carefully to prevent breakage, chipping and scoring fixture finish. Do not install damaged plumbing fixtures, replace and return damaged units to equipment manufacturer.

1.6 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide gas turrets as manufactured by one of the following:

1. Amico
2. Chicago Faucets

2.2 GENERAL

A. Provide factory-fabricated fixtures of type, style and material indicated. For each type fixture, provide fixture manufacturer's standard trim and valves as shown by their published product information and indicated in the plumbing fixtures schedule; either as designed and constructed or as recommended by manufacturer and as required for complete installation.

B. All fixtures of same type must be furnished by a single manufacturer.

C. Where type is not otherwise indicated, provide fixtures complying with governing regulations.

D. Unless otherwise specified, comply with applicable Federal Specification WW-P-541/- series sections pertaining to plumbing fixtures, fittings, trim, metals and finishes. Comply with requirements of WW-P-541/- specification relative to quality of ware, glazing, enamel, and composition and finish of metals; even though some plumbing fixtures specified in this Section are not described in WW-P-541/-.

E. Where fittings, trim and accessories are exposed or semi-exposed, provide bright chrome-plated or polished stainless steel units. Provide copper or brass where not exposed.

2.3 MATERIALS

A. Provide deck mounted gas turrets with needle valves, full flow serrated nozzles, 2 ½" cross handle, needle valve compression operating cartridge and male thread shank assembly.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify all dimensions by field measurements. Verify that all plumbing fixtures may be installed in accordance with pertinent codes and regulations, the original design and the referenced standards.

B. Examine roughing-in work of gas piping systems to verify actual locations of piping connections prior to installing turrets. Correct any incorrect locations of piping and other unsatisfactory conditions for installation of plumbing fixtures. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION

A. Install all plumbing fixtures where shown on the drawings, at the indicated heights. Install in accordance with fixture manufacturer's written instructions, roughing-in drawings and with recognized industry practices.

3.3 DELIVERY, STORAGE, HANDLING, PROTECTION

A. Store all fixtures and materials on site or off site to avoid damage due to construction activity and weather.

B. Provide protective covering for installed fixtures and trim.

C. Do not allow use of fixtures for temporary facilities unless expressly approved in writing by Architect.

3.4 CONNECTIONS

A. Make final gas connections and provide necessary piping, materials and fittings for a complete installation.

3.5 CLEANING

A. Remove all fixture labels and clean all fixtures to remove stains.

END OF SECTION 22 40 43

SECTION 22 40 50
ELECTRIC WATER COOLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes electric water coolers, materials, and installation requirements.

B. Extent of plumbing fixtures work required by this Section is indicated on drawings and schedules and by requirements of this Section.

C. Furnish equipment, materials, labor, and supervision as required for complete installation of plumbing fixtures as specified herein.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of plumbing fixtures of type, style and configuration required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 CODES AND STANDARDS

A. ANSI Standards: Comply with applicable ANSI standards pertaining to plumbing fixtures and systems.

B. PDI Compliance: Comply with standards established by PDI pertaining to plumbing fixture supports.

C. Federal Standards: Comply with applicable FS WW-P-541/-Series sections pertaining to plumbing fixtures.

D. UL Compliance: Construct water coolers in accordance with UL Standard 399 "Drinking Water Coolers" and provide UL listing and label.

E. ASHRAE Compliance: Test and rate water coolers in accordance with ASHRAE Standard 18 "Method of Testing for Rating Drinking Water Coolers and Self-Contained Mechanical Refrigeration Systems".

F. ARI Compliance: Construct and install water coolers in accordance with ARI Standard 1010 "Drinking Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers," and provide Certification Symbol.

G. Regulatory Requirements: Comply with requirements of the Americans with Disabilities Act (ADA) of 1990 with respect to plumbing fixture requirements for the physically handicapped; providing accessibility and usability for physically handicapped people.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide electric water coolers as manufactured by one of the following:

1. Elkay
2. Halsey Taylor
3. Oasis
4. Haws

2.2 GENERAL

A. Provide factory-fabricated fixtures of type, style and material indicated. For each type fixture, provide fixture manufacturer's standard trim, carrier, and valves as shown by their published product information and indicated in the plumbing fixtures schedule; either as designed and constructed or as recommended by manufacturer and as required for complete installation.

B. All fixtures of same type must be furnished by a single manufacturer.

C. Provide materials which have been selected for their surface flatness and smoothness. Exposed surfaces which exhibit pitting seam marks, roller marks, foundry sand holes, stains, discoloration or other surface imperfections on finished units are not acceptable.

D. Where fittings, trim and accessories are exposed or semi-exposed, provide bright polished stainless steel units.

2.3 CONSTRUCTION

A. Provide electric water coolers as indicated and scheduled on the drawings.

B. All water coolers shall be constructed with heavy-gauge galvanized steel frame and stainless steel back panel and fountains. Finish shall be satin finish stainless steel. Bubble guards shall be constructed of plastic. All materials of construction in contact with domestic water shall be lead free. All water coolers shall utilize integral compressors with five (5) years warranty.

C. Where indicated, units shall be barrier-free, and shall be installed per ADA requirements.

D. Where indicated, water cooler shall include a sports bottle filler (alcove) with independent infrared activation.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify all dimensions by field measurements. Verify that all plumbing fixtures may be installed in accordance with pertinent codes and regulations, the original design and the referenced standards.

B. Examine roughing-in work of potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Also examine floors and substrates and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping and other unsatisfactory conditions for installation of plumbing fixtures. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION REQUIREMENTS

A. Install all plumbing fixtures where shown on the drawings, at the indicated heights. Install in accordance with fixture manufacturer's written instructions, roughing-in drawings and with recognized industry practices.

B. Where required, install fixtures in compliance with the requirements of The Americans with Disabilities Act. For handicapped accessible water closets, mount flush valve handle on the access side of the fixture.

C. Install all fixture carriers and supports in accordance with manufacturers published instructions. Securely fasten carriers and supports to the building structure.

D. Install all fixtures square with wall, level and plumb. Secure all traps, stops and supplies to prevent any movement.

E. Install all stops, supplies, traps and escutcheons as required for a complete installation. Locate all fixture stops within the fixture.

F. Protect installed plumbing fixtures from damaged until construction is completed and accepted by Owner. Remove protective covering when ready for use.

3.3 DELIVERY, STORAGE, HANDLING, PROTECTION

A. Store all fixtures and materials on site or off site to avoid damage due to construction activity and weather.

B. Provide protective covering for installed fixtures and trim.

C. Do not allow use of fixtures for temporary facilities unless expressly approved in writing by Architect.

3.4 CONNECTIONS

A. Make final water connection and provide necessary piping, materials and fittings for a complete installation.

B. Make final drain and vent connections and provide necessary piping, materials and fittings for a complete installation.

3.5 CLEANING

A. Remove all fixture labels and clean all fixtures to remove stains.

END OF SECTION 22 40 50

SECTION 22 40 90
EMERGENCY FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes emergency plumbing fixtures, materials, and installation requirements.

1. Extent of work required by this Section is indicated on drawings and schedules and by requirements of this Section.

B. Furnish equipment, materials, labor, and supervision as required for complete installation of plumbing fixtures as specified herein.

C. This section covers:

1. Emergency showers.
2. Eyewash equipment.
3. Self-contained eyewash equipment.
4. Personal eyewash equipment.
5. Eye/face wash equipment.
6. Hand-held drench hoses.
7. Combination units.
8. Water-tempering equipment.

1.3 DEFINITIONS

A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

C. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.

D. Tepid: Moderately warm – Between 85°F to 110°F.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of plumbing fixtures of type, style and configuration required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.5 CODES AND STANDARDS

A. Plumbing Fixture Standards: Comply with applicable portions of local plumbing codes pertaining to materials and installation of plumbing fixtures.

B. ANSI Standards: Comply with applicable ANSI standards pertaining to plumbing fixtures and systems.

C. PDI Compliance: Comply with standards established by PDI pertaining to plumbing fixture supports.

D. Federal Standards: Comply with applicable FS WW-P-541/-Series sections pertaining to plumbing fixtures.

E. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment".

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

G. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities and Public Law 101-336, "Americans with Disabilities Act" for plumbing fixtures for people with disabilities.

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

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 EMERGENCY PLUMBING FIXTURES

A. General: Provide factory-fabricated fixtures of type, style and material indicated. For each type fixture, provide fixture manufacturer's standard trim, carrier, accessories and valves as shown by their published product information and indicated in the plumbing fixtures schedule; either as designed and constructed or as recommended by manufacturer and as required for complete installation. Where more than one type is indicated, selection is Installer's option; but, all fixtures of same type must be furnished by single manufacturer. Where type is not otherwise indicated, provide fixtures complying with governing regulations.

2.2 MATERIALS

A. General: Unless otherwise specified, comply with applicable Federal Specification WW-P-541/-Series sections pertaining to emergency plumbing fixtures, fittings, trim, metals and finishes. Comply with requirements of WW-P-541/specification relative to quality of ware, glazing, enamel, composition and finish of metals, air gaps and vacuum breakers, even though some plumbing fixtures specified in this Section are not described in WW-P-541/-.

B. Provide materials which have been selected for their surface flatness and smoothness. Exposed surfaces which exhibit pitting seam marks, roller marks, foundry sand holes, stains, discoloration or other surface imperfections on finished units are not acceptable.

C. Where fittings, trim and accessories are exposed or semi-exposed, provide bright chrome-plated or polished stainless steel units. Provide copper or brass where not exposed.

D. Stainless Steel Sheets: ASTM A167, Type 302/304, hardest workable temper.

1. Finish: No. 4, bright, directional polish on exposed surfaces.

E. Vitreous China: High quality, free from fire cracks, spots, blisters, pinholes and specks, glaze exposed surfaces and test for crazing resistance in accordance with ASTM C554.

F. Synthetic Stone: High quality, free from defects, glaze on exposed surfaces, stain resistant.

2.3 PLUMBING FITTINGS, TRIM AND ACCESSORIES

A. Water Outlets: At locations where water is supplied (by manual, automatic or remote control), provide commercial quality faucets, valves or dispensing devices of type and size indicated and as required to operate as indicated. Include manual shut-off valves and connecting stem pipes to permit outlet servicing without shut-down of water supply piping systems.

B. Vacuum Breakers: Provide where required by governing regulations, including locations where water outlets are equipped for hose attachment.

C. Water Hammer Arrestors: Provide water hammer arrestors where shown on the drawings and as required to prevent water hammer and excessive vibration in the domestic water system. Arrestors to be of size indicated or as recommended by the manufacturer.

D. P-Traps: Include removable P-traps (with clean out plug) where drains are indicated for direct connection to drainage system.

E. Carriers: Provide cast iron supports for fixtures of either graphitic gray iron, ductile iron or malleable iron as indicated.

F. Fixture Bolt Caps: Provide manufacturer's standard exposed fixture bolt caps finished to match fixture finish.

G. Escutcheons: Where fixture supplies and drains penetrate walls in exposed locations, provide chrome-plated sheet steel escutcheons with friction slips.

H. Aerators: Provide aerators as permitted by local health department. Note: aerators are not approved for use in Health care facilities.

I. Comply with additional fixture requirements contained in fixture schedule on drawings.

J. Restrictors' provide flow restricting orifice in faucets where restraint of flow is required.

2.4 EYEWASH EQUIPMENT

A. Acceptable Manufacturers: Subject to compliance with requirements, provide emergency eyewash equipment as manufactured by one of the following:

1. Bradley Corporation.
2. Encon Safety Products.
3. Guardian Equipment Co.
4. Haws Corporation.
5. Kewaunee.
6. Speakman Company.

B. Description: Provide plumbed, freestanding eyewash equipment.

1. Capacity: Deliver potable water at rate not less than 0.4 gpm for at least 15 minutes.
2. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
3. Stay-Open Control-Valve Actuator: Paddle.
4. Receptor: Chrome-plated brass bowl.
5. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2.

C. Description: Provide plumbed, accessible wall-mounting eyewash equipment with receptor and wall bracket.

1. Capacity: Deliver potable water at rate not less than 0.4 gpm for at least 15 minutes.

2. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
3. Stay-Open Control-Valve Actuator: Paddle.
4. Receptor: [Chrome-plated brass or stainless-steel] [Plastic] bowl.
5. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2.

D. Description: Provide plumbed, accessible wall-mounting eyewash equipment with wall bracket.
1. Capacity: Deliver potable water at rate not less than 0.4 gpm for at least 15 minutes.
2. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
3. Stay-Open Control-Valve Actuator: Paddle.

E. Description: Provide plumbed, adjacent-to-sink, swivel, counter-mounting eyewash equipment.
a. Capacity: Deliver potable water at rate not less than 0.4 gpm for at least 15 minutes.
b. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
c. Stay-Open Control-Valve Actuator: Paddle.

2.5 HAND-HELD DRENCH HOSES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide hand-held drench hoses as manufactured by one of the following:
1. Bradley Corporation.
2. Encon Safety Products.
3. Guardian Equipment Co.
4. Haws Corporation.
5. Kewaunee.
6. Speakman Company.

B. Description: Provide plumbed, wall-mounting, hand-held drench hose with wall bracket, self-closing valve with lever handle, incline vacuum breaker, chrome street elbow and escutcheon plate.
a. Capacity: Deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.
b. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Paddle.
d. Hose: Plain, stainless steel.
e. Spray Heads: Twin.

C. Description: Provide plumbed, counter-mounting, hand-held drench hose with self-closing valve with lever handle, incline vacuum breaker, chrome street elbow and escutcheon plate.
a. Capacity: Deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.

b. Supply Fitting: NPS 1/2 brass with flow regulator.

c. Hose: Rubber or plastic.

d. Control-Valve Actuator: Hand-held squeeze valve.

2.6 COMBINATION UNITS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide combination units as manufactured by one of the following:

1. Bradley Corporation.
2. Encon Safety Products.
3. Guardian Equipment Co.
4. Haws Corporation.
5. Kewaunee.
6. Speakman Company.

B. Description: Provide plumbed, accessible freestanding, with emergency shower and eyewash equipment.

a. Piping: Galvanized steel.

1). Unit Supply: NPS 1-1/4 minimum top.

2). Unit Drain: Outlet at side near bottom.

3). Shower Supply: NPS 1 with flow regulator and stay-open control valve.

4). Eyewash Supply: NPS 1/2 with flow regulator and stay-open control valve.

b. Shower Capacity: Deliver potable water at rate not less than 20 gpm for at least 15 minutes.

1). Control-Valve Actuator: Treadle.

2). Shower Head: 8-inch minimum diameter, chrome-plated brass or stainless steel.

c. Eyewash Equipment: With capacity to deliver potable water at rate not less than 0.4 gpm for at least 15 minutes.

1). Control-Valve Actuator: Paddle.

2). Receptor: Chrome-plated brass or stainless-steel bowl.

2.7 WATER-TEMPERING EQUIPMENT

A. Acceptable Manufacturers: Subject to compliance with requirements, provide water-tempering equipment as manufactured by one of the following:

1. Armstrong International, Inc.
2. Bradley Corporation.
3. Encon Safety Products.
4. Haws Corporation.
5. Lawler Manufacturing Co., Inc.
6. Leonard Valve Company.
7. Powers, a Watts Industries Co.
8. Speakman Company.

B. Description: Provide factory-fabricated, hot- and cold-water-tempering equipment with thermostatic mixing valve.

a. Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify all dimensions by field measurements. Verify that all plumbing fixtures may be installed in accordance with pertinent codes and regulations, the original design and the referenced standards.

B. Examine roughing-in work of potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Also examine floors and substrates and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping and other unsatisfactory conditions for installation of plumbing fixtures. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION REQUIREMENTS

A. Install all plumbing fixtures where shown on the drawings, at the indicated heights. Install in accordance with fixture manufacturer's written instructions, roughing-in drawings and with recognized industry practices. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Where required, install fixtures in compliance with the requirements of The Americans with Disabilities Act. For handicapped accessible water closets, mount flush valve handle on the access side of the fixture.

C. Install all fixture carriers and supports in accordance with manufacturers published instructions. Securely fasten carriers and supports to the building structure.

D. Install all fixtures square with wall, level and plumb. Secure all traps, stops and supplies to prevent any movement.

E. Install all stops, supplies, traps and escutcheons as required for a complete installation. Locate all fixture stops immediately below the fixture. Nipples between copper piping and fixtures stops shall be brass, not galvanized steel. Where exposed, nipples shall be chrome plated.

F. Seal space between plumbing fixtures and wall or floor with white silicone sealant to provide a watertight installation.

G. Protect installed plumbing fixtures from damaged until construction is completed and accepted by Owner. Remove protective covering when ready for use.

H. Provide all stops, supplies, traps and escutcheons necessary for a complete installation.

I. Install ball type shutoff valves in main water-supply to fixtures (above ceilings). Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation.

J. Install wells for thermometers in supply and outlet piping connections to water-tempering equipment.

K. Install trap and waste to wall on drain outlet of fixture receptors that are indicated to be directly connected to drainage system.

L. Install indirect waste piping to wall on drain outlet of fixture receptors that are indicated to be indirectly connected to drainage system.

M. Install equipment nameplates or equipment markers on fixtures and equipment signs on water-tempering equipment.

N. Install all stops, supplies, traps and escutcheons as required for a complete installation. Locate all fixture stops immediately below the fixture. Nipples between copper piping and fixtures stops shall be brass, not galvanized steel. Where exposed, nipples shall be chrome plated.

3.3 DELIVERY, STORAGE, HANDLING, PROTECTION

A. Store all fixtures and materials on site or off site to avoid damage due to construction activity and weather.

B. Provide protective covering for installed fixtures and trim.

C. Do not allow use of fixtures for temporary facilities unless expressly approved in writing by Architect.

D. Handle plumbing fixtures carefully to prevent breakage, chipping and scoring fixture finish. Do not install damaged plumbing fixtures, replace and return damaged units to equipment manufacturer.

3.4 CONNECTIONS

A. Make final cold and hot water connections and provide necessary piping, materials and fittings for a complete installation. Make final drain and vent connections and provide necessary piping, materials and fittings for complete installation.

B. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment.

C. Connect hot- and cold-water-supply piping to hot- and cold-water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures.

D. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary drainage and vent piping.

E. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary or storm drainage piping.

F. Connect cold water and electrical power to electric heating water-tempering equipment.

G. Ground equipment according to Division 16 Sections.

H. Connect wiring according to Division 16 Sections.

3.5 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities and temperatures.

B. Electrical-Component Testing: After electrical circuitry has been energized, test for compliance with requirements.

1. Test and adjust controls and safeties.

C. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

D. Report test results in writing.

3.6 CLEANING

A. Remove all fixture labels and clean all fixtures to remove stains.

3.7 ADJUSTING

A. Adjust or replace fixture flow regulators for proper flow. Adjust all fixture water supplies to provide proper water flow.

B. Adjust equipment temperature settings.

C. Adjust electronic infrared sensor detection range and duration limits for proper fixture operation and to avoid nuisance activation.

END OF SECTION 22 40 90

SECTION 22 41 10
DRAINS AND TRAP PRIMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies drains and trap primers and includes materials, testing and installation methods.

B. The extent of plumbing work required by this Section is indicated on the drawings and schedules and by requirements of this Section.

C. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of plumbing fixtures of type, style and configuration required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 CODES AND STANDARDS

A. All plumbing systems shall comply with the Local Plumbing Code and all requirements of the local authority having jurisdiction.

B. Plumbing systems shall comply with ANSI, ASPE, ASSE, ASTM, CSA, NSF, and AWWA requirements.

C. Trap seal primers shall comply with ASSE 1018.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver drains and trap primers individually wrapped in factory-fabricated containers.

B. Handle drains and trap primers carefully to prevent breakage, chipping and scoring fixture finish. Do not install damaged plumbing fixtures, replace and return damaged units to equipment manufacturer.

1.6 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 FLOOR DRAINS

A. Acceptable manufacturers: Subject to compliance with requirements, provide drains as manufactured by one of the following:

1. Zurn Industries Inc.

2. J.R. Smith
3. Wade
4. Josam.

B. Provide all floor drains with "P" traps with trap primer connection. Furnish all traps 3 inch diameter or less, installed above grade, with clean-out plugs.

C. Provide strainer size and style as indicated on the drawings.

D. Provide models with recessed buckets or sediment traps as indicated on the drawings.

2.2 ROOF DRAINS

A. Acceptable manufacturers: Subject to compliance with requirements, provide drains as manufactured by one of the following:

1. Zurn Industries Inc.
2. J.R. Smith
3. Wade
4. Josam

B. Provide all drains installed in waterproof slabs with a flashing ring, with 30 inch by 30 inch, flashing sheet properly fastened to the flashing ring.

C. Outlet connection shall be threaded or no-hub type. Caulking or gasket type outlets are not acceptable.

D. Furnish emergency overflow roof drains with water dam collar, of height as indicated on the drawings. In no case shall the height of the water dam allow the build up of water to such a height as to exceed the support capabilities of the structure.

2.3 AREA DRAINS

A. Acceptable manufacturers: Subject to compliance with requirements, provide drains as manufactured by one of the following:

1. Zurn Industries Inc.
2. J.R. Smith
3. Wade
4. Josam.

B. Provide all drains installed in waterproof slabs with a flashing ring, with 30 inch by 30 inch, flashing sheet properly fastened to the flashing ring.

C. Outlet connection shall be threaded or no-hub type. Caulking or gasket type outlets are not acceptable.

D. Provide strainer and traffic bearing duty as indicated on the drawings.

2.4 OVERFLOW STORM DISCHARGE SPOUT

A. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes and gargoyle lips.

B. Size: Same as connected conductor.

2.5 TRAP SEALS

A. Acceptable manufacturers; Subject to compliance with requirements, provide trap guards as manufacturer by one of the following:

1. J.R. Smith
2. Pro Vent Systems
3. ProSet Systems

B. Furnish trap guard IAPMO and ASSE listed

C. Trap guard shall insert into the floor drain body and shall close off the trap when the drain is not in use to minimize evaporative loss of trap seal fluid.

2.6 TRAP PRIMER VALVES

A. Acceptable manufacturer: Subject to compliance with requirements, provide trap primer valves as manufactured by one of the following:

1. Precision Plumbing Products, Inc.
2. Mifab
3. J.R. Smith
4. Wade
5. Zurn

B. Furnish with corrosion resistant brass body, 1/2" threaded inlet and outlet, with backflow preventer seal and vacuum breaker port.

C. Valves shall contain no springs or diaphragms.

D. "O" ring seals tested for reliability at a temperature range of –40° to 450°F.

E. Designed to automatically activate when the domestic water system pressure drops as little as 5 psi.

F. Provide with distribution unit and supply tube for multiple (maximum of 4) floor drain installations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install trap primer valves to maintain water in traps and to prevent back-siphonage of sewer gases through the drains. Piping from trap primer valve/distribution unit to floor drains serving equipment (water heaters, etc.) can be above floor for short distances (3' maximum) if it does not interfere with access to and servicing of equipment.

3.2 CONNECTIONS

A. Trap Primers

1. Coordinate piping connection size and style with domestic cold water piping.
2. Tie into dedicated connection hub on drain or fixture trap. Coordinate traps requiring trap primers to provide necessary connection hubs where required.

3.3 TESTING

A. All fittings installed in the domestic water piping system shall be subjected to the same system integrity verification testing as the piping. See the domestic water piping specification section for processes and procedures.

B. All fittings and drains installed in the sanitary, storm and vent piping systems shall be subjected to the same system integrity verification testing as the piping. See the sanitary, storm and vent piping specification section for processes and procedures.

3.4 FIELD QUALITY CONTROL

A. Upon completion of installation of Plumbing Specialties and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements.

B. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new unit sand proceed with retesting.

END OF SECTION 22 41 10

SECTION 22 42 10
HOSE BIBBS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 22 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies hose bibbs and includes materials, testing and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of plumbing fixtures of type, style and configuration required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 CODES AND STANDARDS

A. All plumbing systems shall comply with the Local Plumbing Code and all requirements of the local authority having jurisdiction.

B. Plumbing systems shall comply with ANSI, ASPE, ASSE, ASTM, CSA, NSF, and AWWA requirements.

C. Vacuum breakers, hose bibs, and wall hydrants shall comply with ASSE Standard 1019.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver drains and trap primers individually wrapped in factory-fabricated containers.

B. Handle drains and trap primers carefully to prevent breakage, chipping and scoring fixture finish. Do not install damaged plumbing fixtures, replace and return damaged units to equipment manufacturer.

1.6 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 22 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 22 01 40.

PART 2 - PRODUCTS

2.1 EXTERIOR HOSE BIBBS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide wall hydrants as manufactured by one of the following:

1. Smith (Jay R.) Company
2. Watts Drainage Products
3. Zurn Industries, Inc.; Hydromechanics Division

B. Exterior, non-freeze design with valve remotely mounted inside the heated portion of the building.

C. Furnish with bronze valve body and stainless steel face.

D. Furnish with quarter turn, removable "T" handle.

E. Furnish with integral vacuum breaker and integral dual check valve.

F. Furnish valve meeting ANSI A112.21.3M specifications, and complying with ASSE 1019-B, 1052 and 1053.

2.2 INTERIOR HOSE BIBS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide wall hydrants as manufactured by one of the following:

1. Zurn Industries, Inc.

2. J.R. Smith

3. Wade.

4. Chicago Faucet.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify all dimensions by field measurements. Verify that all units may be installed in accordance with pertinent codes and regulations, the original design and the referenced standards.

B. Examine roughing-in work of potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Also examine floors and substrates and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping and other unsatisfactory conditions for installation of plumbing fixtures. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 CONNECTIONS

A. Exterior Hose Bibbs:

1. Coordinate wall thickness with General Contractor for determination of valve stem length.

2. Coordinate piping connection size and style with domestic cold water piping.

3. Coordinate exterior wall opening size with General Contractor.

B. Interior Hose Bibbs

1. Coordinate piping connection size and style with domestic cold water piping.

C. Installation: provide vacuum breakers on all threaded hose bib connections.

3.3 TESTING

A. All fittings installed in the domestic water piping system shall be subjected to the same system integrity verification testing as the piping. See the domestic water piping specification section for processes and procedures.

B. All fittings and drains installed in the sanitary, storm and vent piping systems shall be subjected to the same system integrity verification testing as the piping. See the sanitary, storm and vent piping specification section for processes and procedures.

3.4 DISINFECTION

A. Components installed in the domestic water piping system shall be subjected to the same chlorination process as the piping. See the domestic water piping specification section for processes and procedures.

B. Verify components and internal parts of all fittings subjected to system chlorination are compatible with the chemicals used in the chlorination process.

3.5 FIELD QUALITY CONTROL

A. Upon completion of installation of Plumbing Specialties and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements.

B. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new unit sand proceed with retesting.

END OF SECTION 22 42 10

SECTION 23 00 10
DOCUMENT INTERPRETATION AND GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this section. Contractors and Subcontractors shall also examine Architectural, Structural, Plumbing, Mechanical, Electrical and all other Drawings and Specifications pertinent to this project. The above mentioned Drawings and Specifications for all the Divisions are part of the Contract Documents.

1.2 SCOPE

A. This section describes the requirements for demolition of HVAC equipment, materials, and systems and defines equipment and material salvage rights.

B. This Section specifies requirements of Codes and Standards to which this project, including all manufactured equipment, on-site fabrication, and installation of all materials and equipment must conform.

C. This Section specifies the basic requirements and procedures for shutting down existing, active Mechanical systems.

D. This Section specifies the basic requirements and procedures for shutting down existing, active HVAC systems and includes requirements for temporarily services should a system need backfed during an unavoidable shut-down or need to remain operational at all times. Temporary services portion of this section supplements and expands on the requirements of Division 1.

1.3 INFERRED PHRASES

A. Where the words “submit”, “submitted”, “approval”, or “approved” or similar are used without an object of the verb, the phrase shall be assumed to read: “Submit to the Construction Manager”, “Submitted to the Construction Manager”, or “Approved by the Construction Manager” as appropriate, unless otherwise noted.

B. The word “provide” shall be understood to mean “furnish and install”.

C. The word “set” shall be understood to mean “install”

D. Reference is made within these Specifications and on the drawings to “General Contractor”. There is no “General Contractor” on this project per se. There is a Construction Manager on this project. It shall be understood that all references to “General Contractor” shall mean the Trade Contractor assigned by the Construction Manager to perform the work.

1.4 PERMITS

A. Unless noted otherwise, this Contractor shall secure and pay for all permits and certificates of inspection required for the work under this Division.

B. Deliver all certificates and official records of approval, by governing agencies, to the Architect.

1.5 CODES

A. Reference to the codes and standards listed shall constitute the minimum acceptable requirements. Nothing in the Specifications shall be construed to permit deviation from the requirements of the governing code. Where requirements of the Drawings and Specifications exceed those of the code listed, follow the Drawings and Specifications.

B. The scope of work shall include the furnishing of systems, equipment and materials specified in this division and as called for on the Drawings and on the Schedules. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section. Work shall include supervision, operations, methods and labor for the fabrication, installation, start-up and tests for the complete installation.

C. Install work in full accordance with rules and regulations of State, County and City authorities having jurisdiction over premises. This shall include safety requirements of the State of Ohio Division of Industrial Relations and OSHA.

A. All wiring shall be in compliance with the current edition of the National Electric Code, Applicable State Code, applicable local (city) code, and OSHA. In cases of conflict between code and specifications, the more restrictive requirements shall govern.

B. All equipment, materials and installation methods shall comply with the following, where applicable:

1. Building Officials and Code Administrators International (BOCA)
2. Codes and Standards Association (CSA)
3. International Building Code (IBC)
4. International Mechanical Code (IMC)
5. National Building Code (NBC)
6. National Electric Code (NEC)
7. National Fire Protection Association (NFPA)
8. National Pressure Vessel Code
9. Occupational Safety and Health Administration (OSHA)
10. Ohio Building Code (OBC)
11. Ohio Mechanical Code (OMC)
12. Standard Building Codes (SBC)
13. Standard Mechanical Codes (SMC)
14. International Association of Plumbing and Mechanical Officials (IAPMO)
15. Uniform Building Codes (UBC)
16. Uniform Mechanical Codes (UMC)

1.6 STANDARDS

A. All equipment, materials and installation methods shall comply with the following, where applicable.

1. Air Conditioning and Refrigeration Institute (ARI)
2. Air Conditioning, Heating, and Refrigeration Institute (AHRI)
3. American National Standards Institute (ANSI)
4. American Society for Testing and Materials (ASTM)
5. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
6. American Society of Mechanical Engineers (ASME)
7. American Society of Sanitary Engineering (ASSE)
8. American Water Works Association (AWWA)

9. American Welding Society (AWS)
10. Building Officials and Code Administrators International (BOCA)
11. Cast Iron Soil Pipe Institute (CISPI)
12. Codes and Standards Association (CSA)
13. Fluid Sealing Association (FSA)
14. International Association of Plumbing and Mechanical Officials (IAPMO)
15. National Institute of Standards and Technology (NIST)
16. National Pressure Vessel Code
17. National Roofing Contractors' Association (NRCA)
18. National Sanitation Foundation (NSF)
19. National Science Foundation (NSF)
20. Plastic Pipe Institute (PPI)
21. Sheet Metal & Air Conditioning National Contractors' Association (SMACNA)
22. Underwriter's Laboratories of Canada (ULC)
23. Underwriters Laboratories, Inc. (UL)

1.7 DESIGN DRAWINGS

A. The Contract Drawings, as submitted, are diagrammatic and are not intended to show exact location of equipment, piping and ductwork unless dimensions are given. Equipment, piping, and ductwork are to be installed along the general plans shown on the Drawings, but keeping in mind actual building conditions.

B. Because of the scale of the drawings, certain basic items may not be shown, but where such items are required by other Sections of these specifications or where they are required by the nature of the work, they shall be furnished and installed. Rough-in dimensions and locations shall be verified with the supplier of all equipment furnished by other trades or by the Owner prior to the time of roughing-in.

C. All equipment, piping and material specified hereinafter as shown on the Drawings shall be furnished and installed by this Contractor, unless specifically indicated to the contrary.

D. If this Contractor proposes to install equipment requiring space conditions other than those as specified and/or shown on the Contract Drawings, or to rearrange the equipment, he shall assume full responsibility and expense for the rearrangement of the space and shall obtain full written approval before proceeding with the work.

E. This Contractor shall locate all equipment that must be serviced, operated or maintained in fully accessible positions. Minor deviations from the Contract Drawings may be made to allow for better accessibility, but changes of magnitude, or which involve extra cost, shall not be made without approval. Ample space shall be allowed for removal of all parts that may require replacement or service in the future.

F. The Drawings and the Specifications are cooperative and supplementary. It is the intent of both said Drawings and Specifications to cover all mechanical requirements in their entirety as nearly as possible. This Contractor shall closely check the Drawings and Specifications for any obvious errors or omissions, and bring any such condition to the attention of the Design Professional prior to the receipt of bids, in order to permit clarification by means of an Addendum. If there are no questions prior to the bid proposal date, the Architect shall assume that the Drawings and Specifications are complete and correct and will expect the intent of said documents to be complied with, and the installation to be complete in all respects according to said intent.

G. This Contractor shall have a complete set of drawings including Architectural, Structural, Plumbing, Fire Protection and Electrical drawings on the site at all times. Prior to installing any work, this Contractor shall check the drawings for exact dimensions and see that the work does not interfere with clearance required for beams, foundations, finished columns, conduits, pilasters, partitions, piping, ductwork, etc., as shown on the drawings and details. After work is installed, if interferences develop that have not been called to the attention of the Architect before the installation, this Contractor shall, at the Contractor's own expense, make such changes in work as directed by the Architect.

H. Extra costs which might result from deviations from the Drawings, so as to avoid interferences, shall be considered a "Job Condition", and no additional compensation will be considered applicable. In the event that such interferences occur in the course of the Work, due to an error, omission, or oversight by the Contractor, no additional compensation shall be allowed. Interferences which may occur during the course of construction shall be brought to the immediate attention of the Architect, and his/her decision, confirmed in writing, shall be final.

1.8 EXAMINATION OF SITE

A. Before submitting a bid, it is recommended that each Contractor visit the site and become familiar with conditions affecting this work. No additional payment will be made on claims that arise from lack of knowledge of existing conditions.

1.9 BASIS OF DESIGN EQUIPMENT

A. Where more than one manufacturer is listed in the Specifications as being acceptable, it shall be understood that the “basis of design” manufacturer is the manufacturer included in the equipment schedule or with the model number listed. Subject to project requirements, all other listed manufacturers are considered as acceptable alternatives. If installation of an acceptable alternative alters the design, electrical or space requirements indicated on the Drawings, this Contractor shall bear the costs for the revised design and construction including costs of all trades involved.

B. The acceptable alternative boiler manufacturers listed in these specifications have different dimensional footprints, clearance requirements, gas pressure requirements, ducted combustion air sizing requirements, flue/vent sizing requirements and electrical requirements that deviate from the “Basis of Design” boiler. If any of the acceptable alternative boiler manufacturers are chosen, this Contractor shall submit a ¼” scale drawing of the boiler room to the Engineer for approval. The ¼” scale drawing shall address all deviations from the basis of design manufacturer including combustion air and flue/vent sizes approved by the acceptable alternative boiler manufacturer. This Contractor shall include all costs for the alternative boiler manufacturer’s deviations in the bid.

1.10 EQUIPMENT AND MATERIALS

A. Prior to the signing of the Contract, the successful bidder may be required to submit a list of manufacturers of the major items of equipment he proposes to furnish and the names of any subcontractors he proposes to employ.

B. When two or more items of same equipment type are required (pumps, fans, valves, etc.) they shall be of the same manufacturer.

C. All equipment and materials shall be new.

D. Provide material and labor which is neither drawn nor specified but which is obviously a component part of and necessary to complete work and which is customarily a part of work of similar character.

1.11 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of equipment, of types and sizes required whose products have been in satisfactory use in similar service for not less than 3 years.

1.12 COORDINATION AND SUPERVISION

A. This Contractor shall examine the work of other trades and shall so coordinate and schedule work as not to cause delays or interference with work of others.

B. Coordinate structural openings and the setting of sleeves with other trades, to accomplish the installation of equipment, ductwork and piping with minimal cutting through concrete or masonry.

C. Coordinate the installation of all required supporting devices, inserts and hangers in structural components as they are constructed.

D. Install HVAC equipment and components (valves, dampers, etc.) to facilitate servicing, maintenance and repair or replacement. Coordinate the final location of concealed equipment and components requiring access with the final location of access doors and panels. Allow adequate space for proper servicing, maintenance and repair. Make final connections to equipment with consideration for future disconnection and removal with minimal interference with other installations.

E. Where installation is to occur in an area with no ceiling and mounting heights are not detailed or dimensioned on the Drawings, install equipment components and systems to provide maximum possible headroom.

F. Install additional piping and ductwork offsets as required to obtain maximum headroom or to avoid conflicts with other work, without additional cost to the Owner.

G. Before installing work, report any interferences between work of this Division and work of other Divisions to the Architect as soon as they are discovered. The Architect shall determine which work must be relocated, or make adjustments to maintain clearances and required headroom and to avoid conflict with other work. If any work is installed so that the Architectural design cannot be adhered to, this Contractor is liable for cost of making such changes as the Architect may require.

H. Ceiling grid systems shall not be supported from equipment, ductwork or piping and vice versa. Where interferences occur, in order to support ductwork, piping, ceiling grid systems, etc., trapeze type hangers or supports shall be employed which shall be located so as not to interfere with access to HVAC equipment such as valves, dampers, etc.

I. Provide adequate competent supervision at all times when work is being performed. Cooperate with all other trades to avoid interferences and delays.

1.13 PROTECTION OF WORK AND PROPERTY

A. The Contractor shall be responsible for safeguarding work, property and facilities against damage, from the Contractor's own personnel as well as others, with which may come into contact in the performance of the work.

B. Stored materials shall be protected against damage from weather. Pipe and duct openings shall be closed with caps or plugs during installation. All equipment shall be covered and protected from damage. Any materials or equipment damaged at any stage in the construction shall be replaced or repaired and shall be in a clean, unblemished condition at project turnover.

C. Protect floors and walls against staining and abrasion from chips and cutting oil where pipe cutting and threading machines are used.

D. Protect equipment and finished surfaces from welding, soldering, brazing and burning with baffles and blankets.

E. Use drop cloths to protect finished surfaces from paint and insulation adhesive droppings.

1.14 DELIVERY, STORAGE AND HANDLING

A. This Contractor shall pay all costs for the transportation of materials and equipment, included in this contract, to the job site.

B. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels and other information needed for identification.

C. Each Contractor shall make provisions for the delivery and safe storage of materials and equipment in coordination with the work of others. Materials and equipment shall be delivered at such stages of the work as will expedite the work as a whole and shall be marked and stored in such a way as to be easily checked and inspected.

D. Handle equipment and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged equipment or components; replace with new.

E. Comply with manufacturer's ringing and installation instructions for unloading equipment and moving them to final location.

F. The arrival and placing of large equipment items shall be scheduled early enough to permit entry and setting when there is no restriction or problem due to size and weight.

1.15 CLEAN-UP

A. Refer to Division 1 for general requirements for final cleaning.

B. Insofar as this Division is concerned, at all times keep premises and building in a neat and orderly condition, follow explicitly any instructions of the Architect in regard to storing of materials, protective measures, cleaning-up of debris, etc.

C. Cap all open ends of ductwork during construction to eliminate the accumulation of construction dust inside ductwork. If dust accumulates during construction, ductwork shall be cleaned prior to project turnover.

D. Upon completion of work remove all tools, equipment, surplus materials, etc. from the project site.

E. Prior to project turn-over thoroughly clean all piping, and equipment, removing all dirt, grease, oil and dust. It is important that all dust accumulated inside control panels is removed. It is recommended that steps are taken to eliminate this dust buildup during construction.

F. If air handling equipment is approved for use to provide temporary service, do not operate without proper filtration. Filters shall be installed at the inlets of all return air ductwork and the inside surface shall be cleaned prior to project turnover. Replace all filters used during construction with proper system filters prior to project turn-over.

1.16 DAMAGE AND EMERGENCY REPAIRS

A. Assume responsibility for any damage caused by leaks in any piping system being installed or reworked under this Contract. Repair all damage without extra cost to Owner. Restore building, piping, insulation etc. to their original condition.

B. The Owner reserves the right to make emergency repairs as required to keep equipment in operation, without voiding Contractor's guarantee or relieving him of responsibility during the warranty period.

1.17 WARRANTIES

A. This Contractor shall warrant for a period of one year (from the date of final acceptance) that all work and equipment will remain free from all defects in workmanship and materials, and that it will comply with all the specific requirements of the Specifications and other Contract Documents governing the work.

B. All work found to be defective will be replaced with new work meeting all the requirements of the Contract. This Contractor will bear all costs of supplying such new work, and installing and finishing same, and will assume all costs for replacing other work damaged by the removal and replacement of any of the work.

C. Include copies of all warranties in the operation and maintenance manuals.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Examine areas and conditions where equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

B. Install equipment as indicated, and in accordance with manufacturer's installation instructions. Uncrate units and inspect for damage. Verify that nameplate data corresponds with unit designation.

C. Locate equipment, plumb and level, firmly anchored in locations indicated. Coordinate with other trades to assure correct recess size for recessed units. Hang ceiling units from building substrate, not from piping. Support units with rod-type hanger anchored to building substrate.

D. All equipment shall be installed with adequate clearance provided for routine maintenance and servicing. Locate horizontal, above-ceiling units to maintain access with ceiling components below.

3.2 DEMOLITION WORK - SERVICES

A. Active Services:

1. When encountered, support active mechanical services as necessary. If active services require relocation (other than those indicated on the drawings), obtain written instructions before proceeding. Do not disturb active services scheduled to remain.

B. Inactive or Abandoned Services:

1. When encountered, remove inactive and abandoned ductwork and piping full length. Removal shall include all hangers and supports. Notify servicing utility when encountered outside of structure.

C. Interruption of Service:

1. See "HVAC System Shut-downs" section for procedures and requirements.

D. Tie-ins:

1. In areas where new construction ties into existing facilities or in remodeled areas, dismantle the existing mechanical facilities as necessary. Relocate any existing services interfering with construction.

3.3 DEMOLITION WORK – GENERAL

A. Remove equipment, materials, and systems as indicated on the drawings and per this section.

B. Remove or relocate those mechanical services specifically indicated on the drawings and as required to complete demolition work.

C. Remove all existing mechanical equipment, piping, ductwork, devices, controls and wiring in remodeled areas that interfere with new construction and are not necessary to maintain services that are to remain.

D. Relocate, or extend as required, mechanical equipment, piping, ductwork, devices and wiring that interfere with new construction and is essential to maintain service to equipment and devices that are to remain.

E. Remove or relocate those mechanical services specifically indicated on the drawings and as required to complete demolition work.

F. All piping and ductwork and wiring to be removed shall be removed full length back to the active source.

G. All holes or damage caused by the removal of existing work shall be properly patched. Holes shall be neatly patched with suitable materials to match existing surfaces.

3.4 SAFE DISPOSAL OF HAZARDOUS MATERIALS

A. Mechanical Contractor shall safely dispose of all hazardous materials encountered in full compliance with all Federal, State, and EPA regulations.

B. Mechanical Contractor shall identify installed facilities requiring removal or modification that are suspected to contain asbestos insulation. If suspicious insulation is encountered, the Mechanical Contractor will cease demolition or modifications and shall notify the Owner.

C. The Mechanical Contractor shall not be responsible for removal of asbestos insulation.

D. The Mechanical Contractor shall work with the owner's asbestos removal and abatement contractor to prioritize abatement work and develop a schedule for removal of hazardous materials so as not to affect the mechanical contractual timeframe.

3.5 SALVAGE

A. Mechanical equipment, piping and devices that are to be removed shall be offered to the Owner for salvage. Equipment, piping and devices selected shall be stored on the site at areas designated by the Owner.

B. All items not selected for salvage by the owner shall become the property of the Mechanical Contractor and shall be removed from the site by the Mechanical Contractor.

3.6 SYSTEM SHUT-DOWNS

A. General

1. The Contractor shall work with the Owner to schedule and plan required system shutdowns. The Contractor shall identify all necessary shutdowns and shall identify the approximate date shutdowns will be required at the outset of the project.

2. The Owner shall reserve the right to dictate final time and date of all shutdowns. The Contractor shall perform all shutdowns at the time and date as directed by the Owner, even if they are required to be performed on weekends or after normal business hours.

3. The Contractor shall work with the Owner's personnel to identify isolation valves in the existing systems requiring shut-down to properly isolate active portions of the system from the targeted inactive portion of the system. Should isolation valves not be present, or not be functional, the Owner shall be notified of the deficiency. In any case, the shut-down shall still be required and deficiencies of the existing system shall be planned around.

B. Steam and Condensate System

1. The Contractor shall isolate the portion of the system where tie-ins or demolition work is to be performed from other portions of the system, as is permitted by the presence of existing isolation valves.
2. The Contractor shall identify all equipment serviced by the portion of the building's steam and condensate system upstream of the targeted work area and upstream of the previously identified isolation valve, if any are present.
3. The Contractor shall identify the approximate amount of time required to perform the work which required that the system be taken out of service.
4. The Contractor shall work with the Owner to identify the optimum time and date that the previously identified equipment can be taken out of service for the previously identified period of time.
5. The Contractor shall perform the necessary work to the existing steam and condensate system at the previously agreed upon date and time. The Contractor shall follow common piping practices or those as identified in other sections of this division to perform said work.

C. Chilled Water System

1. The Contractor shall isolate the portion of the system where tie-ins or demolition work is to be performed from other portions of the system, as is permitted by the presence of existing isolation valves.
2. The Contractor shall identify all equipment serviced by the portion of the building's chilled water system upstream of the targeted work area and upstream of the previously identified isolation valve, if any are present.
3. The Contractor shall identify the approximate amount of time required to perform the work which required that the system be taken out of service.
4. The Contractor shall work with the Owner to identify the optimum time and date that the previously identified equipment can be taken out of service for the previously identified period of time.
5. The Contractor shall perform the necessary work to the existing chilled water system at the previously agreed upon date and time. The Contractor shall follow common piping practices or those as identified in other sections of this division to perform said work.

D. Cooling Coil Condensate Drain System

1. The Contractor shall identify all equipment serviced by the portion of the building's cooling coil condensate drainage system upstream of the targeted work area.
2. The Contractor shall identify the approximate amount of time required to perform the work which required that the system be taken out of service.
3. The Contractor shall work with the Owner to identify the optimum time and date that the previously identified equipment can be taken out of service for the previously identified period of time.
4. The Contractor shall perform the necessary work to the existing cooling coil condensate drainage system at the previously agreed upon date and time. The Contractor shall follow common piping practices or those as identified in other sections of this division to perform said work.

3.7 TEMPORARY SYSTEM BACK-FEED

A. When Required:

1. Amount of work necessitating a system be shutdown requires it to be taken out of service for a period of time greater than is allowed by the building owner.

2. A time and date is not available that fits within the project construction schedule and the owner's use of said system.

B. The Contractor shall arrange for temporary service of the system in question to provide the necessary utility for the building's use while the permanent system is deactivated to perform required work.

C. The cost of any equipment rental, temporary equipment power, hook-up of temporary equipment into the permanent system, etc., required to keep service of a utility to the building's occupants shall be considered a project requirement and shall not be considered additional services which would warrant a change order.

3.8 ADJUSTING AND CLEANING

A. General: After construction is complete, including painting, clean all equipment exposed surfaces.

B. Retouch any marred or scratched surfaces of factory-finish, using finish materials furnished by the manufacturer.

END OF SECTION 23 00 10

SECTION 23 00 90
LEED REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE

A. This section describes the general requirements for LEED related construction requirements to be performed by this division's contactor under this project's contract.

1.2 CODES AND STANDARDS

A. LEED v4 for BD+C: Schools

1.3 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 10.

C. Start-up Report: Provide completed start-up form, per the requirements of Section 23 03 20.

D. Submit documentation outlined below to the Engineer for LEED construction credit submittal

1.4 ABBREVIATIONS

A. GPM - Gallons per minute

B. VOC - Volatile organic compound

PART 2 - PRODUCTS

2.1 ENERGY AND ATMOSPHERE (EA)

A. EA Prerequisite Credit – Minimum/Optimize Energy Performance

1. Furnish and install service hot water heating equipment of exact model (or approved equal) and performance as scheduled on the design drawings.

2. Service hot water heating equipment shall meet the minimum efficiency requirements as outlined in ASHRAE Standard 90.1-2007 Chapter 7.

B. EA Credit 5 - Measurement and Verification

1. Furnish and install domestic water and natural gas sub-meters as indicated on the design drawings.

2.2 INDOOR ENVIRONMENTAL QUALITY (IEQ)

A. General

1. For LEED IEQ Credits – Reference the Sheet Metal and Air-Conditioning Contractors National Association (SMACNA) – Indoor Air Quality Guidelines for Occupied Buildings Under Construction 2nd Edition 2007.

B. IEQ Credit Pre-requisites and Credits

1. During construction, the following practices shall be implemented, photographed, observed, recorded, and reported to the engineer on a bi-weekly basis by this contractor:

2. HVAC Protection

a. When the HVAC systems are off, all supply, return, exhaust, and outside air ducts, equipment and openings should be sealed tightly with filter media and plastic for further protection from particulates.

b. When HVAC systems must be operational during construction, temporary filters shall be used. Filters shall be a Minimum Efficiency Reporting Valve (MERV) of 8 or equivalent efficiency and shall be installed at each return air grille as recommended by ASHRAE 52.2-1999.

c. Check and seal all leaks in the supply, return, exhaust and outside air ducts and air handlers.

d. HVAC air distribution equipment (ducts, terminal boxes, diffusers, etc.) shall be stored in a clean, protected, and dry location.

e. Check and seal all leaks in the flue vents for domestic hot water heaters. Do not store construction or waste materials in any mechanical rooms.

f. Frequently inspect and maintenance HVAC systems during construction. If considerable accumulation of particles can be observed at grilles and diffusers or if ventilation is restricted, this contractor shall clean the ducts and associated equipment. This decision should be based on a detailed visual inspection of the system.

g. The underfloor air distribution system (UADS) shall be isolated from other areas during construction. If the under floor air plenum becomes contaminated, it shall be cleaned to remove dust and particulates. UADS shall be off during the entire construction period; floor tiles shall be covered to prevent dust, odors, and particulates to enter the plenum.

h. Provide a list of all filtration media (manufacturer, model number, MERV rating and location of installed filter) installed during construction and confirm that each was replaced prior to final occupancy.

i. Maintain building under a slightly negative pressure.

3. Source Control

a. Exhaust pollution sources to the outside through an available exhaust system or portable fans to the outside.

b. Keep lids on containers of wet products or waste material.

c. Keep solvent-containing rags in closed, flame-proof containers.

d. Locate the storage of pollutant sources outside the range of occupied areas.

e. Apply sealers to surfaces with persistent odors.

4. Pathway Interruption

a. Depressurize the work area by adjusting the balance of the HVAC and exhaust systems.

b. At shared building spaces, erect barriers to contain construction area.

5. Housekeeping

a. Control dust with wetting agents or sweeping compounds and use efficient duct collection methods. Floors shall be free of excess duct and construction material waste at the end of each day.

b. Keep all surfaces clean (including inside mechanical equipment).

c. Remove spills or excessive applications of solvent-containing products as soon as possible.

d. Keep site as dry as possible and remove accumulated water.

e. Use a HEPA filter in vacuum cleaners to prevent the aerolization of settled dust.

f. Cover all absorptive materials from moisture damage.

6. Scheduling

a. Sequence the installation of materials to avoid contamination of absorptive materials such as insulation, carpeting, ceiling tile and gypsum wallboard.

b. Upon completion of construction, replace all filtration media immediately prior to occupancy with minimum MERV 13 filters.

C. IEQ Credit

1. This contractor shall perform a "flush-out" of the building as follows:

a. After construction ends, but prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying a total air volume of 14,000 cu. ft. of outdoor air per sq. ft. of floor are while maintaining an internal temperature of at least 60 degrees F and relative humidity no higher than 60%.

b. If occupancy is desired prior to completion of the flush-out, the space may be occupied following delivery of a minimum of 3,500 cu. ft. of outdoor air per sq. ft. of floor area to the space. Once a space is occupied, it shall be ventilated at a minimum rate of 0.30 cfm/sq. ft. of outside air. During each day of the flush-out period, ventilation shall begin a minimum of three hours prior to occupancy and continue during occupancy. These conditions shall be maintained until a total of 14,000 cu. ft/sq. ft. of outside air has been delivered to the space.

c. Air handling units shall utilize MERV 13 filters during the flush-out period. A daily log shall document air handling units start/stop times and indoor temperature/ humidity (taken 4 times daily) and outside air quantity of each unit.

D. IEQ Credit - Low-Emitting Materials - Adhesives and Sealants

1. Aerosol adhesives must comply with the Green Seal Standard for Commercial Adhesives GS-36 requirements.

2. Provide plumbing adhesives and sealants conforming to the minimum VOC requirements of this credit as outlined in the following schedule.

Table 23 00 90.1

Application	VOC Limit (g/L less water)
ABS Welding	325
Adhesive Primer for Plastic	550
Caulking and Sealants	420 max
Contact Adhesive	80
CPVC Welding	490
Plastic Cement Welding	250
PVC Welding	510

Application	VOC Limit (g/L less water)
Special Purpose Contact Adhesive	250

PART 3 - EXECUTION

3.1 GENERAL

A. This building is to be a LEED (Leadership in Energy and Environmental Design) certified building, **silver** standard.

B. This contractor shall provide all manpower required to meet the LEED credit requirements outlined in the Division 1 specification section "LEED REQUIREMENTS."

C. Perform the testing and certification requirements outlined in this section and indicated to be performed by the Mechanical Contractor.

D. Assist the Commissioning Agent and any required Third Party Testing Agents in their required duties to ensure all construction related requirements are met and documented.

3.2 EA PREREQUISITE - FUNDAMENTAL COMMISSIONING

A. Assist the Commissioning Agent to perform his required duties.

B. Provide a representative of the Mechanical Contractor familiar with all building systems and equipment installed to assist the Commissioning Agent during the system testing phase of commissioning.

C. Provide a representative of the Temperature Controls Contractor and the Balance Contractors familiar with all building systems and equipment installed to assist the Commissioning Agent during the system testing phase of commissioning.

3.3 EA CREDIT – ADVANCED ENERGY METERING

A. Provide all sensors and measurement devices as indicated on the drawings for data collection to verify compliance with this credit's requirements.

B. Provide dedicated temperature controls graphics to catalog and display necessary data. See division 25 for further details.

3.4 IEQ CREDIT - CONSTRUCTION IAQ MANAGEMENT PLAN

A. Reference the Sheet Metal and Air-Conditioning Contractors National Association (SMACNA) – Indoor Air Quality Guidelines for Occupied Buildings Under Construction 2007 Edition.

B. During construction, the following practices shall be implemented, photographed, observed, recorded, and reported to the engineer on a bi-weekly basis by this contractor:

C. HVAC Protection

1. When the HVAC systems are off, all supply, return, exhaust, and outside air ducts, equipment and openings should be sealed tightly with filter media and plastic for further protection from particulates.

2. When HVAC systems must be operational during construction, temporary filters shall be used. Filters shall be a Minimum Efficiency Reporting Valve (MERV) of 8 or equivalent efficiency and shall be used at each return air grille as recommended by ASHRAE 52.2-1999.

3. Check and seal all leaks in the supply, return, exhaust, and outside air ducts and air handlers.

4. HVAC air distribution equipment (ducts, terminal boxes, diffusers, etc.) shall be stored in a clean, protected, and dry location.

5. Check and seal all leaks in the flue vents for domestic hot water heaters. Do not store construction or waste materials in any mechanical rooms.

6. Frequently inspect and maintenance HVAC systems during construction. If considerable accumulation of particles can be observed at grilles and diffusers or if ventilation is restricted, this contractor shall clean the ducts and associated equipment. This decision should be based on a detailed visual inspection of the system.

7. Provide a list of all filtration media (manufacturer, model number, MERV rating and location of installed filter) installed during construction and confirm that each was replaced prior to final occupancy.

8. Maintain building under a slightly negative pressure.

D. Source Control

1. Exhaust pollution sources to the outside through an available exhaust system or portable fans to the outside.

2. Keep lids on containers of wet products or waste material.

3. Keep solvent-containing rags in closed, flame-proof containers.

4. Locate the storage of pollutant sources outside the range of occupied areas.

5. Apply sealers to surfaces with persistent odors.

E. Pathway Interruption

1. Depressurize the work area by adjusting the balance of the HVAC and exhaust systems.

2. At shared building spaces, erect barriers to contain construction area.

F. Housekeeping

1. Control dust with wetting agents or sweeping compounds and use efficient duct collection methods. Floors shall be free of excess duct and construction material waste at the end of each day.

2. Keep all surfaces clean (including inside mechanical equipment).

3. Remove spills or excessive applications of solvent-containing products as soon as possible.

4. Keep site as dry as possible and remove accumulated water.

5. Use a HEPA filter in vacuum cleaners to prevent the aerolization of settled dust.

6. Cover all absorptive materials from moisture damage.

G. Scheduling

1. Sequence the installation of materials to avoid contamination of absorptive materials such as insulation, carpeting, ceiling tile and gypsum wallboard.

2. Upon completion of construction, replace all filtration media immediately prior to occupancy with minimum MERV 13 filters.

3.5 IEQ CREDIT - IAQ ASSESSMENT

A. Reference the Sheet Metal and Air-Conditioning Contractors National Association (SMACNA) – Indoor Air Quality Guidelines for Occupied Buildings Under Construction 2007 Edition.

B. This division's contractor shall assist the third party testing agency in performing necessary testing as follows:

1. The air handling system will need to be fully functional for the testing process. Testing will occur prior to Owner occupancy, so filtration media should not be the permanent media. Filtration media shall also be installed by this contractor over each intake grille to protect cleanliness of the duct systems.
2. The HVAC protective measures outline previously for IEQ Credit 3.1 shall provide adequate protection, if still in place. If not, duplicate those requirements for compliance with this credit.

C. Air-Quality Testing:

1. A third party testing agency shall be enlisted to perform necessary testing as defined in LEED version 3.0 documents to document compliance.
   a. Acceptable Testing Agencies:
      1). EA Group
      2). KU Resources, Inc.
      3). One Stop Energy Services
   b. The third party testing agency shall be a sub-contractor to this division's Contractor.
2. Conduct baseline indoor-air-quality testing, after construction ends and prior to occupancy, using testing protocols consistent with the EPA's "Compendium of Methods for the Determination of Air Pollutants in Indoor Air," and as additionally detailed in the USGBC's Reference Guide."
3. Demonstrate that the contaminant maximum concentrations listed below are not exceeded:
   a. Formaldehyde: 50 ppb.
   b. Particulates (PM10): 50 micrograms/cu. m.
   c. Total Volatile Organic Compounds (TVOC): 500 micrograms/cu. m.
   d. 4-Phenylcyclohexene (4-PH): 6.5 micrograms/cu. m.
   e. Carbon Monoxide: 9 ppm and no greater than 2 ppm above outdoor levels.
4. For each sampling point where the maximum concentration limits are exceeded, conduct additional flush-out with outside air and retest the specific parameter(s) exceeded to indicate the requirements are achieved. Repeat procedure until all requirements have been met. When retesting noncomplying building areas, take samples from same locations as in the first test.
5. Air-sample testing shall be conducted as follows:
   a. All measurements shall be conducted prior to occupancy but during normal occupied hours, and with building ventilation system starting at the normal daily start time and operated at the minimum outside air flow rate for the occupied mode throughout the duration of the air testing.
   b. Building shall have all interior finishes installed including, but not limited to, millwork, doors, paint, carpet, and acoustic tiles. Nonfixed furnishings such as workstations and partitions are encouraged, but not required, to be in place for the testing.
   c. Number of sampling locations will vary depending on the size of building and number of ventilation systems. For each portion of building served by a separate ventilation system, the number of sampling points shall not be less than one per

25,000 sq. ft. or for each contiguous floor area, whichever is larger, and shall include areas with the least ventilation and greatest presumed source strength.

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

END OF SECTION 23 00 90

SECTION 23 01 10
PROJECT SUBMITTAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section contains:

1. General requirements and procedures for Submittals and Shop Drawings.

2. Requirements for Operation and Maintenance Manuals (O&M manuals) for all Division 23 work.

3. Requirements for record drawings for documentation of installed conditions for all Division 23 work.

B. For specific requirements, see individual specification sections.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Where applicable, the Contractor shall submit:

1. Shop Drawings

2. Operation and Maintenance Manuals

3. Piping System Integrity Test Reports

4. Ductwork Leakage Test Reports

5. Start-up Reports

6. Record Drawings

7. Factory Tests

B. A list of required submittals are specified in each individual specification section.

3.2 SUBMITTAL PROCEDURES

A. Shop drawings

1. Contractor Review

a. This Contractor shall review, stamp and sign with approval all submittals and deliver with reasonable promptness and in orderly sequence so as to cause no delay in the work or in the work of any other Contractor.

b. Submission of shop drawings without review, signature, and approval shall be cause for rejection. Such submittals shall be returned without review.

c. If the submittal includes deviations from the requirements of the Contract Documents, the Contractor shall clearly note the deviations "in red" on the submittal.

2. Electronic Submission
    a. All submittals shall be in electronic format. Electronic submittals shall conform to this specification.
    b. Electronic submittals shall conform to the following requirements:
        1). Electronic submittals shall be in Portable Document Format (.pdf)
            a). Electronic submittals shall include a transmittal.
            b). All portions of the electronic submittal shall be bound in a single .pdf file.
            c). File shall be named to match submittal name as it appears on the individual specification.
                i. Example: "23 22 20 – Grilles and Diffusers".
            d). Submittals shall specifically identify any deviations from the Contract Documents.
        2). Electronic submittals shall include a Contractor review stamp that indicates review and approval by the Contractor prior to submission.
        3). Electronic submittals shall be transmitted via an e-mail:
            a). Provide only one submittal per e-mail
            b). E-mail subject line shall clearly indicate:
                i. Project name
                ii. That the e-mail contains a submittal
                iii. Contents of submittal
    c. Failure to conform the requirements above may result in rejection.
    d. At the Reviewer's discretion, the Reviewer has the option to return the submittals in whatever method is most convenient or appropriate for the Project.
3. Shop Drawing Cover Form
    a. All submittals shall include a Cover form.
    b. Follow the Architects requirements for the cover form.
    c. Cover form shall contain, at a minimum, the following information:
        1). Submitting Contractors Contact information
        2). Shop Drawing Number and Name (As noted in Project Submittal Requirements)
        3). Issue (Original, Resubmittal 1, etc.)
        4). Name of equipment manufacturer
        5). Name of equipment supplier
    d. If the submittal includes deviations from the requirements of the Contract Documents, the Contractor shall clearly indicate such deviations on the shop drawings cover form.
4. Engineer's Review
    a. Shop drawings shall be reviewed only for general compliance and not for dimensions or quantities. The Reviewer will make reasonable efforts to detect and

correct errors, omissions and inaccuracies but shall not be responsible for failure to detect errors, omissions, or inaccuracies. Failure to detect errors, omissions and inaccuracies shall not relieve the Contractor of responsibility for the proper and complete installation in accordance with the intent of the Contract Documents.

b. The Engineer shall mark the shop drawings in one of the ways outlined below. See each description for interpretation of Engineers marks and Contractor responsibilities associated with each.

1). APPROVED: The submittal complies with the requirements of the specifications.

2). APPROVED AS NOTED: The submittal generally complies with the requirements of the specifications but some non-critical items which need to be corrected/coordinated are noted. The corrections shall be changed on the shop drawings submitted for inclusion in the Operations and Maintenance Manual. Re-submittal is not required unless noted otherwise.

3). REVISE AND RESUBMIT: The submittal generally complies with the requirements of the specifications but some critical items which need to be corrected/coordinated are noted. The submittal must be revised and resubmitted with all comments addressed.

4). REJECTED: The submittal does not comply with the requirements of the specifications. The submittal must be revised and resubmitted.

c. Approval of submittal items shall not eliminate the Engineers right to reject those items if defects are discovered prior to final acceptance of the completed work.

B. Operations and Maintenance Manual

1. Submit one (1) copy of the Division 23 manual to the Architect/Engineer for review.

2. After review, address Architect/Engineer's comments and provide the Owner with three (3) hardbound copies of the final approved operating and maintenance manuals for Division 23. Obtain receipt. Note – Operation and Maintenance manuals are required before Owner training takes place.

C. Record Drawings

1. Submit a complete set of red-lined drawings indicating "as-installed" locations of piping, ductwork, and equipment.

3.3 SHOP DRAWING CONTENT

A. Indicate specific options or accessories on shop drawings by pointing to, checking off, or underlining. Do not use highlighter.

B. Do not reproduce Contract Documents or copy standard information as the basis of shop drawings. Standard information prepared without specific reference to the Project is not considered shop drawings and will be cause for rejection.

C. Shop Drawings shall contain the following information, where applicable.

1. General:

a. Model Number

b. Dimensions

c. Weight

d. Clearance requirements

e. Special rigging requirements

f. Material
g. Color and finish
h. Installation recommendations
i. Ratings
j. All included options and accessories

2. Performance:
   a. Performance data as scheduled and/or specified (at a minimum)
   b. Code/standard compliance information
   c. Pressure drop curve or chart
3. Connections:
   a. All pipe and duct connections, including:
      1). Size(s)
      2). Location(s)
      3). Connection service (Supply, return, exhaust, etc.)
      4). Connection method
   b. Electrical connections:
      1). Location(s)
      2). Termination lug size(s)
      3). Plug NEMA configuration
4. Electrical:
   a. Characteristics, including:
      1). Voltage/Phase
      2). Full load and locked rotor amps
      3). Required overcurrent protection and short circuit interrupting capacity
      4). Horsepower of motor(s)
   b. Power wiring diagram
   c. Accessories furnished, including starter(s), disconnect(s), on/off switches, etc.
      1). Clearly indicate if accessories are factory or field mounted/wired.
5. Controls:
   a. Wiring terminations for required interlock and control wiring
   b. Wiring diagram, with factory installed and field installed portions clearly differentiated.
   c. Accessories furnished, including thermostat(s), sensor(s), etc.
      1). Clearly indicate if accessories are factory or field mounted/wired.
   d. Sequences of operation
   e. Integration
      1). Protocol(s), including baud rate.

2). Available points, with read/write capabilities clearly noted.

3). Registers required for integration.

6. Refer to individual specifications sections for special required information.

3.4 OPERATOR AND MAINTENACE MANUAL CONTENT AND FORMAT

A. Binder:

1. Include all materials in a three (3) ring binder or binders, if volume of content dictates multiple books.

2. Provide a type-written cover for the binder indicating project title, contractor firm name and address, date of substantial completion (project finish date), and owner company name.

B. Index:

1. Include a numbered index indicating ALL documents included in the manual.

C. References:

1. Include a page or pages indicating contractor firm name, address, and contact phone number.

2. Indicate the contractor's job foreman, including contact phone number and email address.

3. Indicate all subcontractors utilized, including contact phone numbers and email addresses for each.

4. Name of service agency and installer. Include 24 hour per day emergency phone numbers.

5. Include design Architect reference, including contact phone numbers.

6. Include design Engineer reference.

D. Contents:

1. Provide a separate tabbed section for each specified item type including the following, if applicable:

a. Identification, name, mark, or number as indicated on the design drawings.

b. Final accepted shop drawing, including Engineer's cover form indicating "Accepted" without exception.

c. Manufacturer's maintenance and service manuals including instructions for troubleshooting, disassembly, repair, reassembly, adjusting, aligning, servicing and lubrication.

d. Spare/replacement parts list.

e. Belt sizes, type and lengths (where applicable).

f. Step by step procedures for startup and shutdown of each system and piece of equipment.

g. Copy of equipment start-up report and/or capacity test (if required as part of equipment specification). See Equipment and System Start-up specification section for requirements.

h. Equipment manufacturer's warranty.

2. Automatic controls including device schedules, diagrams and written sequence of operations.

3. Final accepted balance reports as required by this specification.

4. Copy of all system integrity verification report, where required. See Piping Systems Flushing and Testing specification section for requirements.

5. Copy of all piping system flushing, cleaning, and certification reports as required by this Specification.

6. Copy of testing, adjusting, and balancing report as required by this division specification.

7. Copy of Ductwork leakage testing report as required by this division specification.

E. Warranties

1. Contractor warranty including date of final acceptance (this indicates the start of the warranty period).

2. Date of final acceptance shall be issued by the Architect.

F. Electronic Requirements

1. Provide Operations and Maintenance Manuals to Owner and Engineer in .pdf format.

3.5 RECORD DRAWINGS CONTENT

A. Field Documentation

1. This Contractor shall record all changes from original design drawings made during installation. These changes shall be recorded in red ink on a dedicated copy of the final approved construction or coordination drawings. Changes shall be accurately dimensioned and/or drawn to scale.

2. This Contractor shall keep an updated set of prints, including changes, on the job site at all times and shall submit one (1) set of updated and legible "as-built" prints to the Architect when the work is complete.

3. Prepare record documents in accordance with the requirements in Division 1.

4. In addition to the requirements specified in Division 1, indicate the following installed conditions.

a. Ductwork mains and branches and locations of balancing dampers, motor operated dampers, control devices, coils, etc.

b. Piping mains and branches and locations of isolation valves, balance valves, control valves, regulating valves, strainers, expansion devices or loops, air vents, etc.

c. Locations of all equipment.

d. Locations of all equipment controllers, control panels, sensors, control devices, etc.

e. Locations, inverts, and sizes of all underground piping and power.

5. Record documents shall include all deviations from the Contract Documents including any substitutions.

6. If the project requires the preparation of coordination drawings, the coordination drawings shall be submitted as record documents.

END OF SECTION 23 01 10

SECTION 23 01 30
COORDINATION DRAWINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes the requirements for coordination of all trades prior to installation of building systems and the requirements of deliverable coordination drawing sets.

B. Provide pre-construction coordination of all trades and coordination drawings as described in this section.

1.3 RESPONSIBILITIES

A. The **Division 23 Contractor** shall be the lead coordination contractor. The lead coordination contractor shall obtain information from all other trades (plumbing, fire protection, electrical, structural, general, etc.) and assemble this information into a coordination set of drawings. The lead coordination contractor shall manage the coordination drawing execution process.

B. All trades shall review coordination drawings and assist the lead coordination contractor with clash detection and conflict mitigation pertaining to their specific system and equipment.

1.4 SUBMITTALS

A. Provide complete sets of coordination drawings for approval.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 FORMAT

A. Furnish all drawings in **AutoCAD 2019 or later** or **Autodesk Revit 2019 or later**, and as agreed upon by all contractors prior to the commencement of coordination efforts.

B. Scale: ¼”=1’-0” minimum

C. Final drawings shall be submitted as hard copy color print shop drawings for review and approval by the Architect and Engineer.

D. Trades and/or systems shall be assigned a separate color for easy distinction. Colors shall be assigned to all supporting divisions by the lead coordination contractor.

E. All equipment shall be tagged to match the corresponding tag on the construction documents.

F. Photocopied, reproduced or traced drawings of the original Contract Documents shall not be used as coordination drawings.

G. Single line drawings of the ductwork layout will not be allowed to be used as part of Coordination Drawings.

H. Electronic files of the original Contract Drawings will not be allowed to be used as coordination drawings.

3.2 CONTENT

A. Prepare coordination drawings in accordance with Division 1 Section "Project Coordination" and for all areas of the building as follows:

1. Above all ceilings and in all interstitial spaces.
2. For all Mechanical Equipment Rooms and areas where mechanical and plumbing equipment is installed.
3. For all areas where careful coordination is needed for installation of products for and materials fabricated by separate entities.

B. Required Systems

1. Equipment
   a. Air handling units, terminal units, boilers, chillers, cooling towers, heat exchangers, air separators, tanks, pumps, fans, terminal heating equipment, domestic water heating equipment, reduced pressure backflow preventers, plumbing fixtures, etc.
   b. All equipment shall be shown with access areas indicated manufacturer's recommended clearance requirements.
2. Ductwork
   a. Include supply air, return air, exhaust air, relief air, outside air, specialty duct systems, flue and vent duct systems, etc.
3. Piping
   a. Include HVAC piping
   b. Include all division 21 and division 22 piping.
4. Electrical Wiring
   a. Include power, fire alarm, paging, tele-data, low voltage, etc.
5. Electrical Equipment
   a. Include size and location of disconnects, transformers, switchgear, motor control centers, pull boxes, buss ducts, cable trays, lighting fixtures, and starters.
6. Controls
   a. Include sensor locations, panel locations, power, network wiring, low voltage wiring, etc.
7. Building architecture and structure
   a. Walls and associated wall heights.
   b. Structural beams, column locations and elevations.
   c. Slab layout, dimensions with elevations.
   d. Ceiling types and elevations.
8. Special building systems
   a. Include pneumatic transfer tube systems, etc.
9. Miscellaneous
   a. Access panel locations (coordinate type and size with general trades).
   b. Equipment housekeeping pads.

c. Floor drains and floor cleanouts.

d. Framing and suspension details for equipment suspended from above.

10. Existing Conditions

a. Any existing pipe, ductwork or equipment which will impact routing and layout of new work (such as existing storm drains and sanitary/vent piping), shall be field measured by this Contractor and shown on coordination drawings.

C. Quantities, dimensions and locations of equipment connections for piping, ductwork and electrical systems shall be verified with equipment suppliers and included in the preparation of coordination drawings.

D. Show relation of all items of heating, ventilating and air conditioning equipment, ductwork and piping, plumbing equipment and piping and fire protection equipment and piping. Indicate all electrical devices that affect location of heating, ventilating, air conditioning and plumbing equipment, piping, ductwork and air inlets or outlets. Field measure and show existing items affecting new installation in remodeled areas.

3.3 PHASING

A. This project is broken into multiple phases of work. **Spaces surrounding phased work areas are to remain occupied during construction.** Many of these phases require demolition of and alterations to sprinklers, plumbing, HVAC, and medical gas systems within the phased work area that affect surrounding areas outside of the phased work area. Temporary piping and ductwork to areas outside of each phased work area shall be shown on coordination drawings to allow those areas to remain occupied during construction.

3.4 PROCEDURE

A. Review with the construction documents to gain advanced familiarity with the design.

B. Collect Autocad or Revit files from engineer.

C. Schedule

1. Prioritize coordination process with the project schedule to ensure milestones are met and construction activities are not delayed.

D. Modify Drawings

1. Draw in actual sizes of equipment per the approved shop drawings. In areas of the design documents where piping, ductwork, conduit, equipment, etc. are shown diagrammatically, draw in actual to-scale illustrations of same.

2. Identify areas where valves, controls, or other miscellaneous equipment is concealed within walls and add appropriately sized access doors suitable for installation in the associated wall, shaft, or ceiling assembly.

3. Add access clearance boundaries to all equipment specified under this specification division.

4. Review installation details (either from manufacturer's published installation instructions or design installation details) and add miscellaneous items such as concrete housekeeping pads, installation supports, etc. to coordination drawing content covered under this specification division.

E. Consolidate

1. Submit coordination drawings to the Lead Coordination Contractor. The Lead Coordination Contractor shall collect coordination drawings from other trades and compile all content into a single set of coordination drawings.

F. Clash Detection

1. The Lead Coordination Contractor shall overlay all trade content and identify areas of conflict, and then prepare a list of these areas and notify the appropriate trades to meet and review conflicts.

G. Conflict Mitigation

1. Review areas of conflict and develop proposed solutions.
2. Arrange a meeting with the Lead Coordination Contractor and all other trades to review proposed solutions.
3. Select a proposed solution. Each trade affected must indicate acceptance of the illustrated conditions by attaching his endorsement to each drawing.
4. Revise coordination drawings to incorporate proposed solution.

H. Preliminary submission

1. The Lead Coordination Contractor shall bubble / cloud all changes from the original design documents.
2. Any un-resolved coordination items should be indicated via coded notes on the coordination drawings. Engineer/Architect will not review un-resolved coordination items before a thorough review and coordination effort is completed by the contractor.
    a. If there no interferences indicated or bubbles on the coordination drawings, the Engineer and Architect shall assume that the drawings and specifications are complete and correct and will expect the intent of said documents to be complied with, and the installation to be complete in all respects according to said intent.
3. The Lead Coordination Contactor shall submit coordination drawings to the appropriate party in compliance with the project communication chain (i.e. Construction Manager, Architect, Engineer).

I. Engineering's Review

1. Engineer will review and comment on proposed Conflict Mitigation solutions.

J. Re-submissions

1. Incorporate all Architect's/Engineer's comments into coordination drawings.
2. Each trade affected must indicate acceptance of the Engineer's / Architect's revisions by attaching his endorsement to each drawing.
3. The Lead Coordination Contractor may request a coordination meeting between all trades and associated Engineers and Architect as required to complete Conflict Mitigation.
4. Resubmit coordination drawings to Engineer / Architect for review.
5. Perform additional iterations of this procedure as required to mitigate all conflicts and create final-approved coordination drawings.

K. Final Submission

1. Final sign-off coordination drawings (approved by Architect / Engineer) shall be on the job-site at all times.
    a. Record any adjustments from original signed-off coordination drawings that were made during the final installation of the work. See Record Drawings specifications section for further procedures and details.
2. Proceed with installation only after review and approval of coordination drawings by the Architect and Engineer and approval from other trades affected.

END OF SECTION 23 01 30

SECTION 23 02 10
OWNER OPERATING AND MAINTENANCE TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes the general requirements for the purpose of operations and maintenance training of the Owner's facility personnel on the systems and equipment installed or modified under this project's contract.

B. Provide training to the Owner's designated personnel for all equipment and systems listed herein. Individual specification sections indicate the number of training hours required.

1.3 SUBMITTALS

A. Submit to the Architect a schedule of all training sessions, topics to be covered, times, and attending personnel at least fourteen (14) days prior to the first session.

B. Submit to the Architect a sign-in sheet from each training session, with all attending personnel, including contractor's training personnel and manufacturer's representatives, date, number of hours, and time of the training session.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Prior to acceptance of the work and after all equipment is in operation, provide to the Owner instructions for the purpose of training the Owner's personnel in all phases of operation and maintenance of equipment and systems provided under this Division.

B. Contractor shall furnish the necessary trained personnel to perform the demonstrations and instruction, and shall arrange to have the manufacturer's representatives present to assist with the demonstrations where specified.

C. Operation and maintenance manuals shall be provided to the Owner at least fourteen (14) days prior to the first training session.

3.2 TRAINING REQUIREMENTS

A. The demonstrations shall consist of not less than the following:

1. Point out the actual location of each component of a system and demonstrate its function and its relationship to other components within the system.

2. Demonstrate each system by actual "start-stop" operation showing how to work controls, how to reset protective devices, how to replace components requiring regular maintenance, and what to do in an emergency.

3. Demonstrate communication, signal, alarm and detection systems by actual operation of the systems and show how to reset signal, alarm and detection devices.

4. Demonstrate coil pull access is unimpeded.

5. Demonstrate tube-bundle pull for boilers.

3.3 SCHEDULE AND AGENDA

A. Submit a schedule of training events, including proposed date, starting time and ending time of each training session to the Architect/Engineer, Commissioning Agent and Owner prior to the completion of construction for review and approval.

B. Equipment and systems requiring a training session are indicated in each equipment and/or system's dedicated specification section.

C. Indicate required attendees and proposed trainers required for each training session with the event schedule.

D. Indicate proposed training session topic, associated equipment, and rough training session agenda.

3.4 COMMISSIONING AGENT

A. If the project has a Commissioning Agent, the Commissioning Agent shall be present for all training sessions, when commissioning is specified for the project.

3.5 SIGN-OFF

A. If the project has a Commissioning Agent, the Commissioning Agent shall verify completion of training sessions. See attached form.

B. Owner shall verify completion of training sessions. See attached form.

END OF SECTION 23 02 10

SECTION 23 03 10
HYDRONIC PIPING SYSTEMS FLUSHING AND TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies piping systems' testing and cleaning requirements common to more than one section of Division 23. Portions of this Section may not be required in this project.

B. Provide all materials, equipment, labor and supervision necessary to perform all piping testing and cleaning work described in this Section.

C. Cleaning and testing requirements for hydronic piping, steam piping, and refrigerant piping are specified in those specification sections.

1.3 CODES AND STANDARDS

A. All mechanical piping systems shall be tested in accordance with the Local Mechanical Code.

B. All pressure piping systems shall be tested in accordance with the OAC 4101:8 "Pressure Piping System Rules".

1.4 SUBMITTALS

A. Operation and Maintenance Manuals:

1. Include a copy of all pressure test reports.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 INSPECTIONS

A. Obtain all piping inspections required by the authorities having jurisdiction over premises. Furnish all certificates of such inspections and include in the Operating and Maintenance Manuals. Pay all fees necessary for the inspections.

B. No part of system shall be covered before inspection is made and approved. If covered before test, Contractor shall pay for cost of uncovering so test can be made and accepted.

3.2 TESTING - GENERAL

A. See each specific piping system specification section of Division 23 for applicable test and specific testing requirements.

B. Perform piping system pressure tests to all new piping systems prior to final connections to equipment and prior to connection to existing building piping. If equipment is connected, it shall be isolated from the system during the test.

C. Perform all tests before piping is concealed, insulated or heat traced.

D. Contractor is responsible for completely draining the systems after hydrostatic tests are performed. Any damage from freezing prior to acceptance of the completed installation shall be repaired at no additional cost to the Owner.

E. Correct minor leaks in welded joints by chipping out weld and re-welding. Correct leaks in screwed joints by replacing thread or fitting or both. Caulking of threaded joints is not permitted. Repair leaks in copper pipe by sweating out joints, thoroughly cleaning both pipe and fitting, and re-soldering.

F. Contractor is responsible for providing all equipment, power and labor necessary for performing all required inspections and tests.

G. Pressure tests shall be witnessed by Owner's representative.

3.3 HYDRONIC SYSTEMS

A. Each heating water, chilled water, tower water, heat pump closed loop system shall be tested as a whole system or in sections, such that no part of the complete system is left untested. Testing shall comply with the following:

Table 23 03 10.1

Medium	Pressure	Duration	Requirements
Water	1.5 times maximum system design pressure, 100 psig minimum	6 hours	No appreciable pressure loss

END OF SECTION 23 03 10

SECTION 23 03 20
EQUIPMENT AND SYSTEM START-UP

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes equipment and systems general start-up requirements, procedures, documentation, and submission requirements. See individual specifications sections for additional requirements.

B. Furnish all materials, labor, and supervision to properly start-up equipment and systems provided under this Division and as required by this section.

1.3 SUBMITTALS

A. Operations and Maintenance Manuals:

1. Include a copy of all Equipment and System Start-up Forms in the Operations and Maintenance Manuals.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SCHEDULE

A. Coordinate schedule for start-up, testing and adjustments of various equipment and systems with the Architect, other contractors and Owner.

B. Contact all parties, including the Architect, required to witness equipment start-up as indicated in each equipment and system specification section of this division. Contractor shall give at least two (2) week's notice to all parties of scheduled start-up date and time.

3.2 EXAMINATION

A. Prior to start-up verify the following:

1. That each piece of equipment or system is supported properly.

2. That each piece of equipment or system has been checked for proper lubrication, wiring, drive rotation, belt tension, belt alignment, shaft alignment, control sequence or other conditions which may cause damage.

3. Check vibration isolation devices to verify spring locks have been removed and vibration isolators are unconstrained.

4. That all tests, meter readings and specified electrical characteristics agree with those required by the equipment or system.

5. Check equipment containing a separately coupled motor for proper motor and shaft alignment.

3.3 LUBRICATION AND PACKING

A. Properly lubricate all rotating or reciprocating equipment before it is started with correct grade, type and quantity of lubricant as recommended by manufacturer.

B. Check each shaft containing a packing gland condition by backing packing gland off and examining for proper grade, amount and type of packing as recommended by manufacturer.

C. Maintain all lubrication, gaskets and packing during construction. Assure that at the time of final project acceptance all are in first class condition.

3.4 CORRECTION OF DEFICIENCIES

A. Any conditions found to be unsatisfactory to the standards outlined by the manufacturer or these specifications during the cursory pre-start-up examination process shall be corrected prior to actual start-up of equipment and systems.

3.5 EQUIPMENT AND SYSTEM START-UP

A. Follow manufacturer's recommendations and requirements for start-up of equipment.

B. Document date of equipment start-up for commencement of manufacturer's warranty.

C. If required by the specific equipment or system specification section, provide the following:

1. Factory authorized personnel present at site to inspect, check and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

2. Submit a written report that equipment or system has been properly installed and is functioning correctly.

D. During the start up testing or adjustment period, maintain on the project, a contractor representative thoroughly familiar with all phases of the project for as long a period as required to start up all equipment and systems and demonstrate that they are functioning properly.

E. Contractor is responsible for furnishing any and all instruments required to start up and test equipment or systems which include thermometers, electric meters, pressure gauges, etc.

3.6 ADJUSTMENTS

A. Contactor shall make adjustments, if required, to equipment and systems after starting them up and observing them operate for a sustained period of time. Corrections shall be made if systems are excessively noisy or vibrating excessively.

B. The Engineer or his representative, may make spot checks to determine the accuracy and completeness of final adjustments. Should spot checks indicate more than a reasonable deviation from design requirements, the Contractor shall repeat tests and adjustments to the satisfaction of the Engineer.

END OF SECTION 23 03 20

SECTION 23 03 30
TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies of testing, adjusting and balancing requirements including general procedural methods. Provide all equipment, labor and supervision necessary to perform all work described in this Section.

B. The extent of testing, adjusting and balancing work is indicated on the drawings and by requirements of this Section. Requirements include: measurement and establishment of the air and fluid quantities of the air and hydronic systems as required to meet design specifications, adjustment of the flow or equipment speed by adjusting valves or dampers or changing belts and sheaves to obtain desired results and recording and reporting the results.

C. The work of this section shall be the responsibility of the Testing and Balancing Contractor working as an independent Sub-Contractor to the Mechanical Contractor. The Mechanical and Controls Contractors shall provide labor and materials to coordinate with this work.

1. The Mechanical Contractor shall make all changes in sheaves, belts and dampers as required by the Testing and Balancing Contractor. **The Mechanical Contractor shall be responsible to furnish and install replacement sheaves and belts. All variable pitch sheaves shall be replaced with constant pitch sheaves** at the time of final balancing by the Mechanical Contractor.

2. The Mechanical Contractor shall add all balancing dampers as required by the Testing and Balancing Contractor.

3. The Controls Contractor shall verify that all control components are functional, calibrated properly and set for design operating conditions and shall assist the Testing and Balancing Contractor as required for a complete testing, adjusting and balancing of the HVAC System.

4. The Balancing Contractor shall work with the Controls Contractor to establish duct static pressures and hydronic differential pressures for hydronic and air moving equipment. These setpoints shall be noted in the balance report and each equipment sensor location shall also be noted in the balance report.

5. For variable speed fans, fan and motor pulleys shall be replaced with fixed pitch pulleys so that motor is fully loaded at 100% speed (60 hertz). Balance to design air flow by adjusting maximum variable speed drive output below 100%. Note speed (hertz) at which unit attains design flow in balance report.

6. The Balancing Contractor shall work with the variable frequency drive (VFD) manufacturer's start-up representative to determine all resonant frequencies found on VFD-driven fans and pumps. These resonant frequencies shall be noted in the balance reports and shall be programmed by the VFD technician for critical avoidance frequencies.

7. The following devices and equipment shall be measured and documented in the Balance Report:

a. Rooftop Units – Including Return Fans and Powered Exhaust Fans

b. Air Distribution (grilles, diffusers, registers)

c. Exhaust Fans

d. Controls Static Pressure Setpoints

e. Building Pressure Setpoint

f. Air Terminal Boxes

g. Hydronic Coils

h. Hydronic Terminal Units

i. Heating Water Pumps

j. Hydronic Differential Pressure Setpoints

k. Bypass Lines

l. Domestic hot water recirculating pumps and recirculating hot water balance valves gpm

m. Domestic water booster pumps, including controls differential pressure setpoints

1.3 QUALITY ASSURANCE

A. Companies performing work of this Section shall have at least three years experience and specialize in the testing of systems similar to those included for this project.

B. Employ the services of an independent testing, adjusting and balancing agency meeting the qualifications specified below to be the single source of responsibility to test the air distribution systems identified above. Independent means the mechanical contractor shall have no vested interest in the testing and balance agency.

C. Agency shall be an independent testing agency certified by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB) in those testing disciplines required for this project.

D. Perform total system testing in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

E. Project will be commissioned. Refer to other specification sections for additional information and requirements.

1.4 SUBMITTALS

A. Prior to commencement of the work described in this Section, the Testing, Adjusting, and Balancing (TAB) Contractor shall submit verification of his AABC or NEBB certification to the Design Professional for acceptance.

B. Certified Reports:

1. Prior to commencement of the work described in this Section, the Testing, Adjusting, and Balancing (TAB) Contractor shall submit verification of his AABC or NEBB certification to the Design Professional for acceptance.

2. Submit one electronic copy of the testing report bearing the seal and signature of the Test Engineer and the name of the field technician who performed the work (if other than the Engineer).

3. The reports shall be certified proof that the air and water system pressure testing and balancing, including all electrical performance of each piece of HVAC equipment, has been tested in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing procedures; and, are an accurate record of all final quantities measured.

4. Follow the procedures and format herein specified.

C. Report Contents: Provide the following minimum information, forms and data:

1. Provide General Information and Summary information inside the cover sheet to identify testing, adjusting and balancing agency, Contractor, Owner, Engineer and Project. Include addresses and contact names and telephone numbers. Include in this division a listing of the instrumentations used for the procedures along with the proof of calibration.

2. The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms prepared by the AABS or NEBB for each respective item and system.

D. Seasonal Testing: If initial TAB procedures were not performed during near peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near peak summer or winter conditions.

E. 11 Month Warranty Walk: TAB to perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to report unusual conditions with recommendation of adjustments. TAB Contractor shall allow two (2) days for this work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PROCEDURAL REQUIREMENTS

3.2 GENERAL

A. Do not begin adjustments until systems have been completed and are in full working order. All heating, ventilating, exhaust and air conditioning systems and equipment shall be fully operational and shall operate continuously during each working day of testing and balancing.

B. The balancing agency shall adjust and balance all air and water system components to no more than the following tolerances:

1. Supply, Return, and Exhaust Fans: Plus 10 percent to minus 5 percent.

2. Air Outlets and Inlets: Plus or minus 10 percent.

3. Heating Water Flow Rate: Plus 10 percent to minus 5.

4. Cooling Water Flow Rate: Plus or minus 5 percent.

C. The balancing agency shall advise the installing contractor(s) of any additional work required to obtain design performance during the course of the balancing work. Such additional work shall be performed prior to the completion of balancing and submission of the balancing report.

D. During the testing period, this Contractor shall maintain on the job a competent individual thoroughly familiar with all phases of the air and water distribution systems, including controls, for as long a period as may be required to thoroughly adjust all of the systems and to demonstrate to the Architect that they are functioning properly.

E. Perform testing and balancing procedures on each system identified in accordance with the detailed procedures outlined in the referenced standards.

F. Cut insulation on ductwork and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. Patch insulation on piping, ductwork and housings using materials identical to those removed. Holes in ducts and casings used for static pressure and velocity readings shall be provided with removable plugs. Probe locations shall be identified on the duct.

G. The sheet metal contractor shall seal all ducts prior to testing and repair all leaks found during testing.

H. Seal insulation to re-establish integrity of the vapor barrier.

I. Mark equipment settings, including damper hand quadrants, valve indicators, and similar controls and devices to show final settings. Mark with paint or other suitable permanent identification materials.

J. Retest, adjust and balance systems subsequent to significant system modifications and resubmit test results.

K. Check mechanical systems for excessive noise and vibration and include observations in report.

L. Pumps with variable speed drives shall be balanced with balance valves at the pumps 100% open (not including balancing valves at coils).

3.3 PRELIMINARY PROCEDURES FOR HYDRONIC SYSTEM BALANCING

A. Before operating any systems, perform these steps:

1. Open pump balance valves to full open position.
2. Open coil balance valves to full open position.
3. Close coil bypass valves.

3.4 PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING

A. Before operating any systems perform these steps:

1. Obtain design drawings and specifications and become thoroughly acquainted with the design intent.
2. Obtain copies of approved shop drawings of all reheat coils, air inlets and outlets (supply, return and exhaust) and temperature control diagrams.
3. Compare design to installed equipment and field installations.
4. Walk the system from the system air handling equipment to terminal units to determine variations of installation from design.
5. Check filters for cleanliness.
6. Check dampers for correct and locked position and temperature control and safeties for completeness of installation before starting fans.
7. Prepare report test sheets for reheat coils and diffusers, registers and grilles. Obtain manufacturer's diffusers, registers and grilles factors and recommended procedures for testing.
8. Determine best locations in main and branch ductwork for most accurate duct traverses.
9. Place outlet dampers in the full open position.

3.5 REQUIREMENTS FOR SPECIFIC SYSTEM COMPONENTS

A. Diffusers, Grilles, and Registers

1. Identify each diffuser, grille and register as to location and area. Tabulate design velocity and CFM, and test velocity and CFM after adjustment and list size, and type of diffusers, grilles and registers. Adjust supply diffusers, grilles and registers for proper air distribution pattern to eliminate drafts.

B. Air Terminal Units (Boxes)

1. Measure air flows under varying conditions. Set volume controls on all terminal boxes as necessary to meet design requirements. Do not assume factory preset settings are correct.

C. Air Handling Equipment

1. List the data of each fan, motor and drive (belts and sheaves) and obtain by measurement the fan speed, motor voltage, operating amps, fan CFM and static pressure as determined from the manufacturer's fan curves. Also measure the fan CFM by means of a velocity traverse which shall be taken a minimum of three fan diameters from the fan or unit inlet or outlet. Before running any tests, the Contractor shall have installed all the components of the system and insure the cleanliness of the filters. Artificially load air filters by partially blanking of filter bank to produce an air pressure drop midway between cataloged clean and dirty rating. Document pressure drop of each filter bank at which unit was balanced. For belt driven fans, document both sheave sizes and belt sizes. Document measured minimum outdoor air CFM.

2. Provide a unit pressure profile for each air handling unit. Profile shall show each component and the pressure within each unit section (between components) with the unit running at full design flow.

D. Hydronic Equipment

1. All water using equipment shall be balanced to obtain the required water pressure drop and flow. This Contractor shall list the design flow rate and pressure drop and the observed flow and pressure drop for each piece of equipment. Bypass legs on three-way valves shall be balanced to equal pressure drop through the coil at full flow.

E. Pumps

1. List each pump's design data and obtain by measurement each pump motors' voltage, amperage, and pump heads with no water flow and with full water flow. Include copies of manufacturer's pump curve indicating operating point.

F. Miscellaneous Balance Valves

1. Document the design required water flow rate. Measure and record the water flow rate. Tabulate the measured water flow rate as a percentage of the required design flow rate.

END OF SECTION 23 03 30

SECTION 23 03 40
DUCTWORK LEAKAGE TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies Ductwork leakage testing requirements including general procedural methods. Provide all equipment, labor and supervision necessary to perform all work described in this Section.

B. The extent of testing work is indicated on the drawings and by requirements of this Section. Requirements include: measurement and documentation of duct leakage.

C. The work of this section shall be the responsibility of the Testing and Balancing Contractor working as an independent Sub-Contractor to the Mechanical Contractor. The Mechanical and Sheetmetal Contractors shall provide labor and materials to coordinate with this work.

1.3 QUALITY ASSURANCE

A. Companies performing work of this Section shall have at least three years experience and specialize in the testing of systems similar to those included for this project.

B. Employ the services of an independent testing, adjusting and balancing (TAB) agency meeting the qualifications specified below to be the single source of responsibility to test the air distribution systems identified above. Independent means the mechanical contractor shall have no vested interest in the testing and balance agency.

C. Agency shall be an independent testing agency certified by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB) in those testing disciplines required for this project.

D. Perform total system testing in accordance with SMACNA, AABC National Standards for Field Measurement and Instrumentation, Total System Balance, or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.4 SUBMITTALS

A. Certified Reports:

1. Submit a minimum of six (6) copies of the testing report bearing the seal and signature of the Test Engineer and the name of the field technician who performed the work (if other than the Engineer).

2. The reports shall be certified proof that the systems have been tested in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing procedures; and, are an accurate record of all final quantities measured.

3. Follow the procedures and format herein specified.

B. Report Contents: Provide the following minimum information, forms and data:

1. Provide General Information and Summary information inside the cover sheet to identify testing Contractor, Owner's representative who witnessed the testing, Engineer and Project. Include addresses and contact names and telephone numbers. Include in this division a listing of the instrumentations used for the procedures along with the proof of calibration.
2. The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms prepared SMACNA for each respective item and system. Including:
    a. Duct section tested.
    b. Design CFM of tested section.
    c. Duct area (square footage).
    d. Design allowable leakage CFM
    e. Design allowable leakage percentage
    f. Measured duct pressure
    g. Measured actual duct leakage CFM

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 REQUIRED SYSTEMS

A. All supply air ductwork between the air handling unit and the VAV box inlet.

3.2 PROCEDURAL REQUIREMENTS

A. Segments of duct systems may be pressure tested as construction permits (in lieu of the entire air distribution system at project completion). The test report shall identify each air distribution system tested and each segment if tested separately.

B. The sheet metal contractor shall provide all labor and material required to cap segments of the duct systems, including at fans, at air handling units and at air terminal units (boxes).

C. The supply ductwork downstream from air terminal units (boxes) shall be sealed, but shall not be pressure tested.

3.3 DUCT LEAKAGE TESTING

A. The Certified Testing and Balancing Agency shall test and verify tightness of the duct systems as installed under this contract and specifications. The Certified Agency shall conduct all tests in accordance with the AABC or NEBB, National Standards for Field Measurement and Instrumentation. Four (4) copies of the leakage test results shall be submitted to the Architect prior to any duct being concealed by insulation or ceilings or completion of any project "phase".

B. The leak test shall be carried out separately and recorded for each duct system. Maximum allowable leakage is as follows:

1. $F=C_L*P^{0.65}$
    a. F = Max Leakage (cfm/100 ft^2)
    b. C_L = Leakage Class (see Table 23 03 40.1)
    c. P = Pressure (in H_2O)

Table 23 03 40.1

Duct Class	Rectangular Metal Duct Leakage Class (C_L)	Round Metal Leakage Class (C_L)
1/2-, 1-, 2-in wg	24	12
3-in wg	12	6
4-, 6-, 10-in wg	6	3

C. Testing pressure shall be equal to the pressure classification to which the duct was constructed.

D. Test equipment shall consist of:

1. Air blower having minimum capacity of 4% of the total system air quantity for high pressure systems and 10% of the total system air quantity for low pressure systems.
2. Orifice plate or other calibrated acceptable airflow measuring device for a range of 0.1% to 0.2% of the system capacity.
3. Two gauges, one to read the duct S.P. in inches w.g. and the other to read the airflow (except if direct reading instruments are used).
4. Dampering device or other provision to raise duct static pressure (SP) in inches water gauge to the required level.
5. The test equipment shall be installed in a package and shall have approval regarding its capacity. Also, it shall include all ancillary parts (not listed above) required to provide the testing, e.g. flexible connection, extension cord, starter, pilot light, etc.

E. Test procedure shall follow the outline given below:

1. Use the "as-built" drawings to calculate the sheetmetal areas, air capacity and indicate the allowable leak in CFM on a chart. Select the proper airflow measuring device, size of orifice, etc., and show on the same chart. Provide space also for the final leak and duct S.P. recording.
2. The Sheet Metal Contractor shall close off and seal all openings in the duct section to be tested. Connect the test apparatus to the duct by means of a section of flexible duct.
3. Start the blower with its control damper closed.
4. Gradually open the inlet damper until the required duct pressure is reached.
5. Hold this pressure for ten minutes. This brief overloading should reveal marginally constructed joints. Survey all joints for audible leaks. Mark each leak for repair by Sheet Metal Contractor after shutting down the blower. Do not apply a retest until sealants have set.
6. Read the pressure differential across the orifice or other measuring device and compare the data with the CFM chart of the testing device, also the chart prepared for allowable leakage. If CFM is exceeded, further sealing is necessary.
7. Request leak test certification from the manufacturer of the terminal boxes. If this is not available, then carry on the test at random for one of each size terminal unit by blocking off the low pressure side of the outlets. Proceed the same way as described above.

END OF SECTION 23 03 40

SECTION 23 03 50
COMMISSIONING OF MECHANICAL SYSTEMS AND COMPONENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes the general requirements for mechanical equipment and system Commissioning requirements to be performed by this division's contactor under this project's contract.

B. Commissioning work shall be a team effort to ensure that all equipment and systems have been completely and properly installed, function together correctly to meet the design intent, and document system performance.

1.3 SUBMITTALS

A. Submit completed and signed-off pre-functional checklists for record. Include a copy of the signed-off checklists in the operations and maintenance manual.

1.4 ROLES AND RESPONSIBILITIES

A. Commissioning Agent (CxA):

1. Commissioning process leader.

B. Mechanical Contractor (MC):

1. Lead contractor.
2. Perform Pre-functional system and equipment examination and tests.
3. Schedule verification tests for each piece of equipment and system outlined in part 3 of this specification section.
4. Schedule TCC and TAB representatives to be present on site as required for each test as outlined in part 3 of this specification section.

C. Temperature Controls Contractor (TCC):

1. Assist the CxA and MC in verification of proper system operation and compliance with design intent.
2. Compare TAB system measurements to temperature control system's permanent measuring device outputs. Adjust devices to align sensor measurements with TAB measurements.

D. Testing, Adjusting, and Balancing Contractor (TAB):

1. Assist the CxA and MC in verification of proper system operation and compliance with design intent.
2. Verify, during the CxA witnessed equipment and system performance tests, system operation by independent measurement of system pressures, temperatures, flow rates, and electrical currents. Note, the temperature control system may NOT be utilized for verification.

1.5 REQUIRED SYSTEMS AND EQUIPMENT

A. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems, and sub- systems. The following equipment and systems shall be included:

1. Heating water plant (boilers, pumps, etc.)
2. Roof top air handling units.
3. Air terminal devices.
4. Exhaust fans.
5. Automatic dampers.
6. Fire/smoke dampers.
7. Environmental control units.
8. Cabinet unit heaters
9. Unit heaters
10. Building automation system and controls, including control board and interface with systems and equipment provided in other Divisions.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Provide access to measurement equipment for the following parameters:

1. Water Pressure
2. Air Pressure
3. Water Temperature
4. Air Temperature
5. Water Flow
6. Air Flow
7. Electrical Current

2.2 TEST EQUIPMENT – PROPRIETARY

A. Where water flow measurements are required for system verification but no permanent flow measuring devices are installed in the piping system, the contractor shall provide other means of flow measurement such as ultrasonic measuring devices.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall complete all phases of work so the systems can be started, tested, balanced, and commissioning procedures undertaken. This includes the complete installation of all equipment, materials, fixtures, pipe, valves, wire, insulation, controls, etc., per the contract documents and related directives, clarifications, and change orders.

B. The CxA shall be responsible for coordinating and directing each step of the commissioning process.

C. A commissioning plan shall be developed by the CxA. The Contractor shall assist the CxA in preparing the commissioning plan by providing all necessary information pertaining to the actual equipment and installation. If Contractor initiated system changes have been made that alter the commissioning process, the CxA shall notify the Owner.

D. Acceptance procedures are normally intended to begin prior to completion of a system and/or sub-systems, and shall be coordinated with the Division 23 subcontractor. Start of acceptance procedures before system completion does not relieve the Contractor from completing those systems as per the schedule.

E. Attendance is required at a mandatory kick-off meeting by all commissioning team members. Kick-off meeting shall be held at a time and place designated by the Owner. The purpose shall be to familiarize all parties with the commissioning process, and to ensure that the responsibilities of each party are clearly understood.

3.2 EQUIPMENT AND SYSTEM START-UP

A. The CxA shall be informed of all equipment and system start-ups.

B. See dedicated equipment start-up specification section of this division

3.3 PRE-FUNCTIONAL CHECKLISTS

A. Pre-functional checklists are comprised of a full range of checks and tests to determine that all components, equipment, systems, and interfaces between systems operate in accordance with contract documents. These checks and tests are completed by the Division 23 contractor and sub-contractors and documented using pre- functional checklists.

B. The MC shall complete prefunctional checklists for each piece of equipment and/or system. Sample forms are attached to this section, but the MC is permitted to use their own if desired.

C. Systems must be balanced prior to completion of prefunctional testing.

D. Final verification witnessed by the CxA shall not be scheduled until a signed, completed copy of the prefunctional checklist is submitted to the CxA by the MC.

3.4 FINAL TESTING AND VERIFICATION

A. Detailed testing shall be performed on all installed equipment and systems to ensure that operation and performance conform to contract documents. The following testing is required as part of the commissioning process:

1. Functional performance tests (FPT) shall determine if the HVAC system is operating in accordance with the design intent. This includes all operating modes, interlocks, control responses, and specific responses to abnormal or emergency conditions. FPT shall be done by Contractor as "Contractor directed" testing and then tested again during CxA witnessed testing.

2. Integrated Systems Testing (ISTs) shall determine if the HVAC systems are operating in accordance with the design intent, specifically where the HVAC systems have an interface with other building systems, such as the BAS, electrical, plumbing, etc. This includes all operating modes, interlocks, control responses, and specific responses to abnormal or emergency conditions. ISTs shall be done by Contractor as "Contractor directed" testing and then tested again during CxA witnessed testing.

B. The MC shall submit requests for the CxA perform final witnessed FPT’s and IST’s for each system and piece of equipment. The MC shall give a minimum of one (1) week’s notice when scheduling CxA presence for witness testing.

3.5 CORRECTIVE ACTION AND RETESTING

A. In some systems, maladjustments, misapplied equipment, and/or deficient performance under varying loads will result in additional work being required to commission the systems. This work shall be completed under the direction of the Owner, with input from the MC, equipment supplier, and CxA. Whereas all members shall have input and the opportunity to discuss, debate, and work out problems, the Owner shall have final jurisdiction over any additional work done to achieve performance.

B. Corrective work shall be completed in a timely fashion to permit the completion of the commissioning process. Experimentation to demonstrate system performance may be permitted. If the CxA deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the CxA shall notify the Owner, indicating the nature of the problem, expected steps to be taken, and suggested deadline(s) for completion of activities. If the deadline(s) pass without resolution of the problem, the Owner reserves the right to obtain supplementary services and/or equipment to resolve the problem. Costs incurred to solve the problems in an expeditious manner shall be the Contractor's responsibility.

C. The MC is allowed one witnessed re-test without incurring additional costs associated with CxA participation. If systems are not operating properly at the time of the second witness test, the contractor shall correct unsatisfactory condition(s) and shall be responsible for costs associated with further witness tests.

3.6 PARTICIPATION IN COMMISSIONING

A. The MC shall provide skilled personnel to start-up and debug all systems within Division 23. These same personnel shall be made available to assist the CxA in completing the commissioning program. Work schedules, time required for testing, etc., shall be requested by the CxA and coordinated by the Contractor. Contractor shall ensure that the qualified personnel are available and present during the agreed upon schedules and of sufficient duration to complete the necessary tests, adjustments, and/or problem resolutions.

B. System performance problems and discrepancies may require additional personnel time, CxA time, reconstruction of systems, and/or replacement of system components. The additional Contractor personnel time shall be made available for subsequent commissioning periods until the required system performance is obtained at no additional cost to the Owner.

C. The CxA reserves the right to question the appropriateness and qualifications of the personnel relative to each item of equipment, system, and/or sub-system. Qualifications of personnel shall include expert knowledge relative to the specific equipment involved and a willingness to work with the CxA. The MC shall provide adequate documentation and tools to start-up and test the equipment, system, and/or sub-system.

3.7 SEASONAL COMMISSIONING

A. Seasonal commissioning pertains to testing under full load conditions during peak heating and cooling seasons, as well as part load conditions in the spring and fall. Initial commissioning shall be done as soon as contract work is completed, regardless of season. Subsequent commissioning may be undertaken at any time thereafter to ascertain adequate performance during the different seasons.

B. Heating equipment shall be tested during winter design extremes. Cooling equipment shall be tested during summer design extremes.

3.8 OWNER TRAINING

A. Comprehensive training of O&M personnel shall be performed by the MC, and where appropriate, by other sub-contractors, and vendors as specified elsewhere in this division. The CxA will require documentation of all training sessions prior to commissioning process close-out.

END OF SECTION 23 03 50

SECTION 23 04 20
PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies painting requirements for this division and includes descriptions of piping and systems included as part of this division's contract and general application methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

C. Finishing (paint, wall covering, etc.) shall not be included under this Section.

PART 2 - PRODUCTS

2.1 GENERAL

A. All painted metal surface shall be primed and painted with paint. Apply painting to the following areas utilizing Sherwin-Williams materials:

1. Ferrous Metal (Exterior): One coat Galvite HS and two coats All Surface Alkyd Enamel.

2. Oura-Plate 235 multi purpose epoxy.

3. Ferrous Metals (Interior): Spot prime abraded areas with All Surface Enamel Primer and two coats ProClassic Alkyd Interior Enamel.

4. Insulated Coverings: One coat Fast Drying Primer and two coats ProMar 400 Alkyd Semi-Gloss.

B. Equipment touch up painting shall match the equipment finish.

C. See Part 3 – Execution for piping, supports and equipment to be painted.

2.2 ACCEPTABLE MANUFACTURERS

A. Painting shall be done with products as manufactured by Pittsburgh Plate Glass, Sherwin-Williams, Pratt and Lambert or Glidden.

PART 3 - EXECUTION

3.1 LOCATIONS REQUIRING PAINTING

A. General:

1. Exposed iron work, hangers, pipe, pipe covering, equipment casings or enclosures, tanks, and ductwork exterior to mechanical equipment rooms.

2. Where equipment is complete with a factory finish, additional painting is not required unless directed by the Architect/Engineer (requiring a color change).

3. "Exposed" as indicated above, shall refer to exposed to view and shall not include piping or materials concealed above ceilings, under floor slabs, or buried in walls.

B. All exposed hydronic piping serving cabinet unit heaters in stairwells and fin-tube radiators:

1. Color selection to match adjacent building features and surroundings. Final color selection shall be made by the Architect/Engineer.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Materials and equipment installed under this Division shall be left free from dirt, grease and foreign matter, ready for painting.

B. No equipment or piping shall be painted before being tested.

C. Damaged surfaces of prefinished materials and equipment shall be touch-up painted to match existing finish.

D. Comply with manufacturer's recommendations for mixing and application.

E. Do not paint over name plates, labels, identification tags, signs, markers, etc.

F. Surface preparation shall comply with SSPC-SSP2.

3.3 FIELD QUALITY CONTROL

A. Provide protective drop coverings for all permanent finishes and surfaces while applying paint and until the final coating has dried to protect from excess paint spills, drips, etc.

3.4 CLEANING

A. Clean excess paint from any surfaces not meant to be painted.

B. Remove protective coverings once final paint coat has dried.

END OF SECTION 23 04 20

SECTION 23 04 40
CONCRETE EQUIPMENT PADS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The other Specs of this Division complement the requirements of this Section.

1.2 SCOPE

A. This section describes the acceptable materials and installation methods to provide housekeeping pads, curbs, rails, inertia bases, etc., for equipment furnished under this Division.

B. Furnish all equipment, materials, labor, and supervision necessary to provide cast-in-place concrete housekeeping pads, curbs, rails, inertia bases, etc., as described herein and where indicated on the drawings. Extent of mechanical related work required by this Section is indicated on the drawings.

1.3 QUALITY ASSURANCE

A. Concrete Work Codes and Standards: Comply with governing regulations and, where not otherwise indicated, comply with industry standard in its application to work in each instance.

1. ACI 301 "Specifications for Structural Concrete Buildings."

2. ACI 381 "Building Code Requirements for Reinforced Concrete."

3. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice."

1.4 SUBMITTALS

A. Operation and Maintenance (O&M) Manuals

1. Provide manuals, per requirements of Section 23 01 10.

1.5 PROJECT CONDITIONS

A. Protect adjacent finish materials against spatter during concrete placement.

PART 2 - PRODUCTS (NOT APPLICABLE)

2.1 CONCRETE RELATED MATERIALS

A. Forms for exposed finish concrete work shall be of lumber, metal, metal-framed or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces.

1. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

2. Welded Wire Reinforcing Fabric: ASTM A 185, welded steel wire fabric.

3. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place.

2.2 CONCRETE MATERIALS

A. Materials for concrete work shall comply with requirements of other Divisions "Portland Cement Concrete Paving" Section.

B. Portland Cement: ASTM C 150, Type I.

C. Use one brand of cement throughout project, unless otherwise acceptable to Architect. Prepare design mixes for each strength of concrete indicated.

1. Fly Ash: ASTM C 618, Type C or Type F.
2. Fine Aggregate: ASTM C 33, sand.
3. Course Aggregate: ASTM C 33, crushed gravel.

2.3 DESIGN AND PROPORTIONING OF CONCRETE MIXES

A. General:

1. Design mechanical work concrete as follows, for each 28-day compressive strength class:

a. 3000 psi Class: 500lbs. of cement per cubic yard (5.25 sacks) and 0.46 water/cement ratio.

PART 3 - EXECUTION

3.1 INSTALLATION OF CONCRETE

A. Formwork:

1. General: Design, construct, support, brace, and maintain formwork to support vertical and lateral, static and dynamic loads that might be applied until such loads can be supported by concrete structure. Construct formwork so that formed concrete will be of required size, shape, alignment, elevation, and position.

a. Construct forms to retain equipment anchor bolts in accurate locations during placement of reinforcing steel and concrete. Use templates furnished by equipment manufacturers, to locate anchor bolts, or where not furnished, locate by accurate measure from certified setting diagrams.

B. Placing Reinforcement:

1. General: Comply with requirements and recommendations of specified standards, including "Placing Reinforcing Bars" by CRSI's "Manual of Standard Practice."

C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces.

D. Chamfer exposed corners and edges using wood, metal, PVC or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

E. Provisions for Other Trades:

1. Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support built into forms.

F. Cleaning and Tightening:

1. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed. Re-tightening forms and bracing after concrete placement is required to eliminate mortar leaks and maintain proper alignment. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials which would reduce bond with concrete.

G. Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.

H. Place reinforcement to obtain at least minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

I. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.

3.2 PREPARATION OF FORM SURFACES

A. Clean re-used forms of concrete matrix residue, repair and patch as required to return forms to acceptable surface condition.

B. Coat contact surfaces of forms with a form-coating compound before reinforcement is placed.

C. Thin form-coating compounds only with thinning agent of type, amount, and under conditions of form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.

D. Coat steel forms with a non-staining, rust preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

3.3 REMOVAL OF FORMS

A. Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50°F (10°C) for 24 hours after placing concrete, provided concrete sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.

3.4 CONCRETE PLACEMENT

A. Pre-placement inspection:

1. Before placing, inspect and complete formwork installation, reinforcement steel, and items to be embedded or cast-in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where coatings are bot used.

B. General:

1. Comply with ACI 304 "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete", and as herein specified.

C. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation.

D. Consolidate placed concrete by mechanical vibrating equipment supplemented by handspading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.

E. Placing Concrete Slabs:

1. Deposit and consolidate slabs in a continuous operation within limits of construction joints, until the placing of a panel or section is completed.

F. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.

G. Bring slab surfaces to correct level with straightedge and strike-off. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.

H. Maintain reinforcing in proper position during concrete placement operations.

3.5 CONCRETE CURING AND PROTECTION

A. General:

1. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting; keep continuously moist for not less than 7 days.

C. Begin final curing procedures immediately initial curing and before concrete has dried. Continue final curing for at least 7 days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.

1. Cold Weather Placement:

a. Comply with ACI 306. Do not use frozen materials or materials containing ice and snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. When air temperature has fallen or is expected to fall below 40°F (4.4°C), heat water and aggregates uniformly before mixing, as required to obtain concrete mixture temperature of not less than 50°F (10°C), and not more than 80°F (26.7°C), at time of placement. Protect concrete work from physical damage and reduced strength resulting from frost, freezing actions, or low temperatures.

2. Finishing Horizontal Surfaces:

a. Float and trowel horizontal (top) surfaces to level, smooth, uniform textured, dense finish, where surface is to remain exposed or receive coating, membrane or other thin-set finish. Otherwise, leave struck-off surface undisturbed, except scratch surfaces which are to receive concrete or mortar topping or setting bed, by ranking with a stiff broom.

3.6 MISCELLANEOUS CONCRETE ITEMS

A. Curbs:

1. Provide monolithic finish on interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to hard, dense finish with corners, intersections and terminations slightly rounded and coved.

B. Equipment Bases and Foundation:

1. Provide equipment bases and foundations, as shown on drawings. Set anchor bolts for equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing equipment.

C. In the absence of more specific information, either on the drawings, or in manufacturer's literature, concrete bases shall be level, shall have a minimum height above finished floor of 4" and extend 3" beyond the skids, feet or bed plate of the item of equipment.

D. Concrete pads, pedestals, or saddles placed in existing structures shall be mounted securely to the original substrate with anchor bolts.

E. Grout base plates and foundation as indicated, using non-shrink grout. Use non-metallic grout for exposed conditions.

3.7 DELIVERY, STORAGE, HANDLING

A. Deliver, store, and handle steel reinforcement to prevent bending and damage.

3.8 CLEANING

A. Clean area after pad has cured of left-over or spilled concrete, dust, or other materials on-site to facilitate concrete mixing and pouring.

END OF SECTION 23 04 40

SECTION 23 05 10
ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The other Division 23 Specifications complement the requirements of this Section. Separate electrical components and materials for field installation and electrical connections are specified in Division 26.

B. The other Division 23 Specifications complement the requirements of this Section.

C. Separate electrical components and materials for field installation and electrical connections are specified in Division 26.

1.2 SCOPE

A. This Section specifies basic requirements for electrical components which are an integral part of packaged mechanical equipment. These components include, but are not limited to factory installed motors, starters, and disconnect switches furnished as an integral part of packaged mechanical equipment.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings or described in other Sections of Division 23.

C. Provide all materials, equipment, labor and supervision necessary to install all electrical components and devices described in this Section.

D. All field wiring of components and devices described in this Section shall be by the Electrical Contractor as specified in Division 26.

1.3 CODES AND STANDARDS

A. All motors, electrical devices and enclosures shall comply with NEMA and IEEE Standards for the specific application in which installed.

B. Electrical components and integral wiring shall comply with the National Electrical Code (NFPA 70).

C. Electrical components and materials shall be UL labeled.

PART 2 - PRODUCTS

2.1 GENERAL

A. All HVAC equipment control panel and electrical device enclosure covers shall be provided with defeatable interlocks to permit opening of panel (by qualified personnel) while equipment is in operation.

B. Fabricate HVAC equipment for secure mounting of motors and other electrical items integral with the equipment. Provide either permanent alignment of motors with equipment or adjustable mountings as applicable for belt drives, gear drives, special couplings and similar indirect coupling of equipment. Provide safe, secure, durable, and removable guards for motor drives, arranged for lubrication and similar running-maintenance without removal of guards. Guards shall include opening for insertion of revolution counter at motor drive sheave.

2.2 MOTORS

A. For each item of equipment requiring electric drive, provide an induction motor having starting and running characteristics consistent with the torque and speed requirements of the driven equipment. In no case shall power requirements of the driven equipment exceed the nominal nameplate rating of the furnished motor (do not take advantage of service factors in selecting motors). For design, construction and performance characteristics, conform to applicable provisions of latest NEMA and IEEE standards for rotating electrical equipment.

B. Unless otherwise specified, motors are to be general-purpose open-drip proof type, with Class B insulation, rated for continuous operation in 40°C ambient temperature. All motors utilized with variable frequency drives shall be "inverter ready" motor with class F insulation in accordance with NEMA MG1 Part 31.4.4.2. All motors utilized with variable frequency drives shall be provided with a shaft ground ring in compliance with NEMA MG1 31.4.4.3.

1. Unless otherwise scheduled on the drawings, motors 1/2 HP and smaller shall be single phase, capacitor start type, with ball bearings. Shaded-pole type with sleeve bearings are acceptable only for motors less than 1/16 HP.

2. Unless otherwise scheduled on the drawings, motors 3/4 HP and larger shall be three phase, squirrel-cage type with ball bearings.

3. Ball bearings shall be regreasable, except where motor is normally inaccessible for regular maintenance, permanently sealed ball bearings shall be provided.

C. Motors shall have a minimum efficiency as follows in accordance with IEEE Standard 112, test method B. If horsepower is not listed, motors shall have a higher efficiency than "average standard industry motors" in accordance with IEEE Standard 112, test method B.

D. Motors shall be furnished with stainless steel nameplate indicating manufacturer, ratings, characteristics, construction, efficiency and special features.

E. Acceptable motor manufacturers: A.O. Smith, Baldor (Reliance), Emerson, General Electric, Leeson, Louis Allis, Marathon Electric, Teco-Westinghouse.

2.3 MANUAL MOTOR STARTERS

A. In general, single phase motors shall be equipped with manual motor starters. Manual motor starters shall be provided and installed by the electrical contractor as specified in Division 26 unless noted otherwise on the Division 23 drawings or in the Division 23 specifications.

B. Enclosures in dry indoor locations shall be general purpose NEMA Type 1, unless noted otherwise. Enclosures in wet indoor or outdoor locations shall be NEMA Type 4 (stainless steel, unless noted otherwise).

C. Manual motor starter shall include neon pilot light, "Quick-make, quick-break" trip-free toggle mechanism and melting alloy thermal overload relay sized to protect the motor.

2.4 COMBINATION MOTOR STARTERS

A. In general, three phase motors shall be equipped with combination motor starters. Combination motor starters shall be provided and installed by the electrical contractor as specified in Division 26 unless noted otherwise on the Division 23 drawings or in the Division 23 specifications.

B. Enclosures in dry indoor locations shall be general purpose NEMA Type 1, unless noted otherwise. Enclosures in wet indoor or outdoor locations shall be NEMA Type 4 (stainless steel, unless noted otherwise).

C. Size of starters shall be as recommended by the motor or driven equipment manufacturer.

D. Combination motor starters shall include a disconnect as specified in the following section "2.5 Disconnect Switches". Starter shall be furnished with the following devices:

1. "HAND-OFF-AUTO" selector switch in cover.
2. Heavy duty push-to-test red pilot light to illuminate when motor is running.
3. Control power transformer (coordinate secondary voltage with required control voltage). Control transformer primary shall be connected to the load side of the incoming line disconnect fuses and the secondary shall be fused and grounded.
4. Three (3) bi-metal type thermal overload elements. The starter shall be inoperative if any thermal element is removed.
5. Minimum of two NO/NC field convertible auxiliary contacts. Two NO and two NC contacts may be furnished in lieu of convertible contacts.
6. Engraved nameplate on the door describing the equipment controlled.

2.5 DISCONNECT SWITCHES

A. Disconnect switches shall be provided and installed by the electrical contractor as specified in Division 26 unless noted otherwise on the Division 23 drawings or in the Division 23 specifications.

B. In dry indoor locations, enclosures shall be general purpose NEMA Type 1, unless noted otherwise. In wet indoor or outdoor locations enclosures shall be NEMA Type 4 (stainless steel), unless noted otherwise.

C. Size of disconnect switches shall be as recommended by the motor or driven equipment manufacturer.

D. Disconnect switches shall be fusible type, with Class R rejection fuse clips.

1. The disconnect handle shall always be in control of the disconnect device with the door open or closed. The disconnect handle shall be clearly marked as to whether the disconnect device is "ON" or "OFF", and shall include a two-color handle grip, the black side visible in the "OFF" position indicating a safe condition, and the red side visible in the "ON" position indicating a dangerous condition.
2. Disconnect handle shall contain provisions for padlocking in the "OFF" position.
3. If required, the disconnect switch shall be furnished with one auxiliary SPDT contact for use by the Controls Contractor to de-energize remotely powered interlock wiring when the disconnect is in the "OFF" position.

E. Disconnect switches shall be furnished with a ground lug.

PART 3 - EXECUTION

3.1 GENERAL INFORMATION

A. Install motors on motor mounting systems in accordance with motor manufacturer's instructions, securely anchored to resist torque, drive thrusts, and other external forces inherent in mechanical work. Secure sheaves and other drive units to motor shafts with keys and Allen set screws, except motors of 1/3 HP and less may be secured with Allen set screws on flat surface of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.

B. Install starters and wiring devices at location indicated, securely supported and anchored, and in accordance with manufacturer's installation instructions. Locate for proper operational access, including visibility, and for safety.

C. Install power and control connections for motors to comply with NEC and applicable provision of Division 26 sections. Install grounding except where non-grounded isolation of motor is indicated.

D. Prior to the purchase or installation of any equipment, verify all motor voltage characteristics with the Electrical Contractor.

E. Make final electrical connection to all motors with flexible metal conduit unless plug-in electrical cords are specified. Line voltage terminations shall be by the Electrical Contractor.

END OF SECTION 23 05 10

SECTION 23 05 20
VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies variable frequency drives (VFD's) utilized to control the speed of specific motor driven mechanical equipment and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

C. Specific electrical requirements (i.e., horsepower and electrical characteristics) for mechanical equipment are specified herein and scheduled on the drawings.

D. All variable frequency drives that are not an integral part of packaged equipment, shall be furnished by the Contractor designated on the drawings and installed/set/wired by the Electrical Contractor unless otherwise noted as furnished by others.

1.3 CODES AND STANDARDS

A. All variable frequency drives, including installation, shall comply with the requirements of the National Electric Code and the local authorities having jurisdiction.

B. UL Compliance: Provide VFD's that are UL listed and approved.

C. NEMA Standards ICS 7.1 – 2006: Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems.

D. NEMA Standards MG 1: Motors and Generators.

E. NEMA Standards ICS 2: Industrial Control Devices, Controllers and Assemblies.

F. NEMA Standard 250: Enclosures for Electrical Equipment.

G. NEMA Standard KS 1: Enclosed Switched.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of VFD's, of types and capacities required, whose products have been in satisfactory use in similar service for not less than three (3) years.

B. To ensure quality and minimize infantile failures at the jobsite, the complete VFD assembly (including options) shall be tested by the drive manufacturer. The complete drive assembly shall be manufactured in an ISO 9001 certified facility.

C. All optional features shall be functionally tested at the factory for proper operation.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Handle VFD's and components in clean dry place. Product from weather, dirt, fumes, water, constructive debris and physical damage. Retain shipping protective covers and protective enclosures during storage.

B. Store VFD's and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage. Retain shipping protective covers and protective enclosures during storage.

C. Each VFD shall be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD's shall not be operated while covered.

1.6 SUBMITTALS

A. Shop Drawings: Provide Shop Drawings, per requirements of Sections 23 01 10 and 23 01 20.

B. Operation and Maintenance (O&M) Manuals: Provide manuals, per requirements of Section 23 01 40.

C. Start-up Report: Provide completed start-up form, per the requirements of Section 23 03 20.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide variable frequency drives as manufactured by one of the following:

1. ABB Inc.
2. Eaton
3. Danfoss
4. Square D
5. Yaskawa

B. Motors shall be inverter duty rated, per NEMA MG1 parts 30 and 31, for motor-drive compatibility.

2.2 GENERAL

A. Furnish complete variable frequency drives as specified herein for the fans and pumps designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified.

1. In dry indoor locations, VFD shall be housed in a metal NEMA 1 enclosure.
2. In wet indoor locations, VFD shall be housed in a metal NEMA 12 ventilated enclosure.
3. In outdoor locations, VFD shall be housed in a painted steel NEMA 3R ventilated enclosure with thermostatically controlled space heater.

B. The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control and to negate the need for motor derating.

C. An advanced sine wave approximation and voltage vector control shall be used to allow operation at rated motor shaft output at nominal speed with no derating. This voltage vector control shall minimize harmonics to the motor to increase motor efficiency and life.

D. The VFD shall include a full-wave diode bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.

E. The VFD and options shall be tested to ANSI/UL Standard 508. The complete VFD, including all specified options, shall be assembled by the manufacturer, which shall be UL-508 certified for the building and assembly of option panels. Local representative panel shop assembly for option panels is not acceptable. The appropriate UL stickers shall be applied to both the drive and option panel, in the case where these are not contained in one panel.

F. The VFD's full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting.

G. The VFD shall be able to provide full torque at any selected speed up to base speed to allow driving direct drive fans without derating.

H. An automatic energy optimization selection feature shall be provided standard in the drive. This feature shall automatically and continually monitor the motor's speed and load and adjust the applied voltage to maximize energy savings and provide a 3% to 10% additional energy savings.

I. The AC drive power converter shall be protected against short circuits between output phases and also phase-to-ground. Installing Contractor shall supply auxiliary switches on all output disconnecting devices. Auxiliary devices shall be wired to the drives enable circuits, such that opening such device will disable the drives output.

J. An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or decouple the motor from the load to run the test.

K. The VFDs shall include Electromagnetic interference (EMI) and radio frequency interferences (RFI) filters. The EMI/RFI filter shall allow the VFD assembly to meet ISO product standard EN 61800-3. The EMI filters shall be removable to facilitate installation into a high leg (delta) or High Resistance Grounded power systems.

2.3 PROTECTIVE FEATURES

A. Class 20 I^2t electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor applications.

B. Protection against input transients, loss of AC line phase, short circuit, ground fault, overvoltage, undervoltage, drive overtemperature and motor overtemperature. The VFD shall display all faults in plain English. Codes are not acceptable.

C. Protect VFD from sustained power or phase loss. VFD must operate, without fault or failure, when voltage varies plus or minus 10% from rating and when frequency varies plus or minus 5% from rating.

D. The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.

E. Drive shall have semi-conductor rated input fuses to protect power components or, if furnished without fusing, shall be certified and agency tested to provide a minimum withstand rating of 100,000 amp interrupting capacity (AIC) while operating from the VFD or while operating in bypass.

F. To prevent breakdown of the motor winding insulation, the dV/dt must be below 1500 V/msec per IEC recommendations. The supplier shall include with the quotation the dV/dt values of the drive. For each 480V application, provide the following filters:

1. Drive and motor are 0-50 feet apart: no filter.

2. Drive and motor are 50 to 300 feet apart: provide a 3% load reactor.

3. Drive and motor are 300 to 1000 feet apart: provide a TCI Model V1K, dV/dt filter located on the output of the drive. The filter V1K filter shall be sized to the horsepower and voltage rating of the VFD and furnished in a NEMA 1 enclosure.
4. Drive and motor are 1000 feet or more apart: provide a Sine Wave Filter.
5. The total length for Drives that serve multiple motors shall not exceed 100 feet. The length shall be calculated as the total sum of lengths between each motor overload and the motor itself. Filter may be furnished integral in the VFD drive enclosure or in a separate NEMA 1 enclosure. Where this specification applies to any retrofit of an existing motor a TCI Model V1K dV/dt filter shall be required regardless of motor cable length.

G. Drive shall include a "signal loss detection" circuit to sense the loss of the control signal, and shall be programmable to react as desired in such instance.

H. The AC drive power converter shall be protected against short circuits between output phases and also phase-to-ground. Installing Contractor shall supply auxiliary switches on all output disconnecting devices. Auxiliary devices shall be wired to the drives enable circuits, such that opening such device will disable the drives output.

I. Drive shall catch a rotating motor operating forward or reverse up to full speed.

J. VFD shall be rated for 100,000 AIC.

K. Drive shall include motor phase loss protection. Drive shall also display the associated fault.

L. Drive shall continue to operate without faulting until input voltage exceeds 300 volts on 208/230 volt drives, and 604 volts on 460 volt drives.

2.4 INTERFACE FEATURES

A. Hand/Start, Off/Stop and Auto/Start selector switches shall be provided to start and stop the drive and determine the speed reference.

B. Provide a 24 V DC output signal to indicate that the drive is in Auto/Remote mode.

C. Digital manual speed control. Potentiometers are not acceptable.

D. Lockable, alphanumeric backlit display keypad can be remotely mounted up to 10 feet away using standard 9-pin cable. All keypads shall be identical and interchangeable. Drive may be operated with keypad removed. All drives shall use the same control keypad.

E. To setup multiple drives, it shall be possible to upload all setup parameters to the drive's keypad, place that keypad on all other drives in turn and download the setup to each drive.

F. The display shall have four lines, with 20 characters on three lines and eight large characters on one line.

G. Two lines of the display shall allow free programming so that the exact unit controlled by the drive can be identified.

H. A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided on approved manufacturer's standard keypad display. These indications shall be visible both on the keypad and on the drive when the keypad is removed.

I. A quick setup menu with factory preset typical HVAC parameters shall be provided on the drive eliminating the need for macros.

J. Two set-point control interface (PID control) shall be standard in the unit or approved manufacturer's standard programming. Drive shall be able to look at two feedback signals, compare with two set-points and make various process control decisions.

K. Floating point control interface shall be provided to increase/decrease speed in response to switch closures.

L. Sleep mode shall be provided to automatically stop the drive when speed drops below set "sleep" level for a specified time. Drive automatically restarts when speed command exceeds set "wake" level.

M. Run permissive circuit shall be provided to accept a "system ready" signal to assure that the drive does not start until dampers or other auxiliary equipment are in the proper state for drive operation.

N. An elapsed time meter and kWh meter shall be provided.

O. The following displays shall be accessible from the control panel in actual units: Reference Signal Value in actual units, Output Frequency in Hz or percent, Output Amps, Motor HP, Motor kW, kWhr, Output Voltage, No Load Warning, DC Bus Voltage, Drive Temperature in degrees, and Motor Speed in engineering units per application (in percent speed, GPM, CFM,...). Drive will read out the selected engineering unit either in a linear, square or cubed relationship to output frequency as appropriate to the unit chosen.

P. Up to four meter displays can be shown at once on the display. This allows the actual value of the follower signal to be shown simultaneously with the drive's response to that signal for ease in commissioning.

Q. Drive will sense the loss of load and signal a no load/broken belt warning or fault.

R. The VFD shall have approved manufacturer's standard drive temperature controlled cooling fans for quiet operation and minimized losses.

S. The VFD shall store in memory the last 20 faults and record all operational data.

T. Six programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.

U. Two programmable relay outputs, one Form C 240 V AC, one Form A 50 V AC, shall be provided for remote indication of drive status.

V. Two programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include one voltage (0-10 V dc, 2 to 10 V dc) and one current (0 to 20 mA, 4 to 20mA) input.

W. One programmable 0-20 mA analog output shall be provided for indication of drive status. This output shall be programmable for output speed, voltage, frequency, amps and input kW.

X. Under fire mode conditions the VFD shall automatically default to a preset speed.

2.5 ADJUSTMENTS

A. VFD shall have an adjustable carrier frequency.

B. Seven preset speeds shall be provided.

C. Two acceleration and four deceleration ramps shall be provided. Accel and decel time shall be adjustable over the range from 0 to 3,600 seconds to base speed. The shape of these curves may be automatically contoured to prevent tripping.

D. Two current limit settings shall be provided.

E. If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: undervoltage, overvoltage, current limit, and inverter overload.

F. The number of restart attempts shall be selectable from 0 through 5 and the time between attempts shall be adjustable from 0 through 600 seconds.

G. An automatic "on delay" may be selected from 0 to 120 seconds.

2.6 AUTOMATION SYSTEM INTERFACE

A. The VFD's shall communicate directly with the Building Automation System through the local area network.

B. The VFD's shall communicate directly with the building automation system interface network. This connection to the system shall allow all operating parameters, speed control, drive configuration, and status of the drives to be both read and changed through the bus connection. Modulating signal, enable/disable, remote disconnect status and general alarm signals shall be hard wired.

2.7 BYPASS

A. Where indicated, provide a manual bypass consisting of a door interlocked main fused disconnect padlockable in the off position, a built-in motor starter and a three position HAND/OFF/AUTO switch controlling three contactors. In the DRIVE position, the motor is operated at an adjustable speed from the drive. In the OFF position, the motor and drive are disconnected. In the HAND position, the motor is operated at full speed from the AC power line and power is disconnected from the drive so that service can be performed. A Customer supplied normally closed dry contact shall be interlocked with the drives safety trip circuitry to stop the motor whether in AUTO or HAND mode in case of an external safety fault.

2.8 DISCONNECT

A. Provide a door interlocked, padlockable circuit breaker that will disconnect all input power from the drive and all internally mounted options.

2.9 SERVICE CONDITIONS

A. Ambient temperature, -10 to 40°C (14 to 104°F).

B. 0 to 95% relative humidity, non-condensing.

C. Elevation to 3,300 feet without derating.

D. AC line voltage variation, -10 to +10% of nominal with full output.

E. No side clearance shall be required for cooling of any NEMA 1 units, or of any NEMA 12 units of less.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Contractor to verify that job site conditions for installation meet factory recommended and code-required conditions for VFD installation prior to start-up, including clearance spacing, temperature, contamination, dust, and moisture of the environment. Separate conduit installation of the motor wiring, power wiring, and control wiring, and installation per the manufacturer's recommendations shall be verified.

B. The VFD is to be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD shall not be operated while the unit is covered.

3.2 INSTALLATION

A. All variable frequency drives shall be furnished by the designated contractor and installed/set/wired by the Electrical Contractor unless otherwise noted.

3.3 WARRANTY

A. The VFD shall be warranted by the manufacturer for a period of 36 months from date of shipment. The warranty shall include parts, labor, travel costs and living expenses incurred by the manufacturer to provide factory authorized on-site service. The warranty shall be provided by the VFD manufacturer.

3.4 START-UP SERVICE

A. The manufacturer shall provide start-up commissioning of the variable frequency drive and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. The commissioning personnel shall be the same personnel that will provide the factory service and warranty repairs at the customer's site. Sales personnel and other agents who are not factory certified technicians for VFD field repair shall not be acceptable as commissioning agents. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system. Start-up shall include customer operator training at the time of the equipment commissioning.

B. The Balancing Contractor shall work with the variable frequency drive (VFD) manufacturer's start-up representative to determine all resonant frequencies found on VFD-driven fans and pumps through the entire operating range of the equipment. These resonant frequencies shall be noted in the balance reports and shall be programmed by the VFD technician for critical avoidance frequencies.

3.5 DEMONSTRATION AND TRAINING

A. Owner's Instructions: Provide services of a manufacturer's technical representative for two (2) separate 4-hour days to instruct Owner's personnel in operation and maintenance of variable frequency drives.

1. Schedule training with Owner, provide at least 7-day notice to Contractor and Engineer of training date.

END OF SECTION 23 05 20

SECTION 23 07 10
PENETRATIONS AND SLEEVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section specifies basic requirements for wall, foundation wall, roof and floor penetrations.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. Underwriters' Laboratory (UL)

B. ASTM E-84 (NFPA 255)

1.4 SUBMITTALS

A. Slab-on-grade floor and below-grade wall penetrations seal: Submit manufacturer's cutsheet(s), including dimensions, materials, installation recommendations, ratings and code compliance information, etc.

B. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 20.

PART 2 - PRODUCTS

2.1 BELOW-GRADE WALL AND SLAB-ON-GRADE FLOOR PENETRATION SEAL

A. Blow-grade mechanical seals shall consist of intumescent synthetic rubber plugs, plastic or stainless steel pressure plates, and stainless steel bolts.

B. Subject to compliance with requirements, provide below grade wall and floor slab penetration seals as manufactured by one of the following:

1. Metra-Flex

C. Thunderline Corp

2.2 PIPE SLEEVE MATERIALS

A. Schedule 40 black steel pipe.

2.3 SOUND-STOPPING MATERIALS

A. Fiberglass insulation, 2 lb. density.

B. Material shall be non-asbestos and non-friable.

C. Provide all insulation materials with a flame-spread index of 25 or less and smoke developed index of 50 or less, as tested under procedure ASTM E-84 (NFPA 255).

2.4 ESCUTCHEONS

A. Escutcheons shall be two-piece, chrome plated brass.

PART 3 - EXECUTION

3.1 GENERAL

A. Pipe sleeves are required at all pipes penetrating concrete walls, masonry walls, fire walls and smoke barrier walls.

B. Where concrete or masonry walls are core drilled for pipe passage, steel sleeves are not required.

C. Where concrete floor slabs or concrete roof slabs are core drilled for pipe passage, steel sleeves are not required – except in mechanical rooms and all rooms containing water piping.

D. In new concrete walls, floors, and roofs, coordinate the exact locations of pipe sleeves with the General Trades Contractor performing this work prior to concrete pour.

E. Each Contractor is responsible to furnish and install his own pipe sleeves.

3.2 CUTTING AND PATCHING

A. This Contractor shall provide all penetrations required for the installation of Ductwork, HVAC piping, conduit, and equipment. Do not cut any structural member without specific permission from the Architect.

B. Penetrations shall be cut as small as practical with as little damage as possible and in a manner satisfactory to the Architect.

C. This Contractor shall patch all penetrations and repair all damage caused by the installation and/or removal of plumbing systems. All materials shall be new and shall match the adjacent construction.

D. Finishes (paint, wall covering, etc.) shall not be included under this Section.

3.3 MASONRY OR CONCRETE WALL BELOW-GRADE, AND FLOOR SLABS ON-GRADE:

A. Sleeves shall be one inch (1") larger than the outside diameter of the pipe including insulation where applicable, or two pipe sizes larger, whichever is bigger.

B. Set pipe wall sleeves with ends of sleeves flush with wall faces. Set pipe floor sleeves with top of sleeve to be 4 inches above finished floor in water entry rooms, mechanical rooms, and wet floor locations.

C. Center pipes in sleeves.

D. Provide below-grade mechanical wall and floor penetration seals to fill the annular space between the pipe and floor slab or outside wall and sleeve. Center penetration seal within the opening.

E. Comply with penetration seal manufacturer's installation instructions.

3.4 MASONRY OR CONCRETE WALL ABOVE-GRADE

A. Sleeves shall be one inch (1") larger than the outside diameter of the pipe including insulation where applicable, or two pipe sizes larger, whichever is bigger.

B. Set pipe sleeves with ends of sleeves flush with wall faces.

C. Center pipes in sleeves.

D. For fire or smoke rated walls, fill the annular space between the pipe and the sleeve with the proper firestopping material. See "Firestopping" specification section, this Division for products and installation methods.

E. For unrated walls, fill the annular space between the pipe and the sleeve with sound stopping.

3.5 CONCRETE FLOOR OR ROOF:

A. Sleeves shall be 1 inch larger than the outside diameter of the pipe, or two pipe sizes larger, whichever is bigger.

B. Set pipe sleeves with top of sleeve flush with roof slab or deck surface.

C. Set pipe sleeves with top of sleeve to be 4 inches above finished floor in water entry rooms, mechanical rooms and wet floor locations.

D. Center pipes in sleeves.

E. For fire or smoke rated floors and roofs, fill the annular space between the pipe and the sleeve with the proper firestopping material. See "Firestopping" specification section, this Division for products and installation methods.

F. For unrated floors and roofs, fill the annular space between the pipe and the sleeve with sound stopping. Note – roof penetrations shall be made via roof curbs.

3.6 SOUND STOPPING

A. Where pipes or other components of Division 23 work pass through non-fire rated walls, provide sound stopping between such work and the wall material intended to reduce the transmission of sound from on side of the wall to the other.

B. Sound stopping of pipes in sleeves shall consist of sealing the outside of the sleeve with caulking and the inside with an insulating material.

C. Sound stopping of pipes without sleeves shall consist of packing the cavity around the penetration with an insulating material and sealing the opening with approved sealant or plaster.

D. Insulating materials shall be non-asbestos and non-friable, and shall have a flame spread rating of no more than 25 and a smoke developed rating of no more than 50.

3.7 ESCUTCHEONS

A. Fit all pipe passing exposed through walls, floors, or ceilings in finished rooms with chrome-plated brass escutcheons. Where adjacent surface is to receive a paint finish, prime paint escutcheons, otherwise escutcheons shall be chrome plated.

END OF SECTION 23 07 10

SECTION 23 07 11
ROOF PENETRATION CURBS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies roof curbs and rails utilized to support and elevate equipment above roofs. To insure compatibility, roof curbs, rails and supports should be furnished by the rooftop equipment manufacturer, wherever possible, in compliance with this Section.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Roof curbs and support rails furnished by the rooftop equipment manufacturer shall be submitted with the equipment.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver roof curbs and support rails in factory-fabricated crates, containers or wrapping which properly protect roof curbs and support rails from damage.

B. Store roof curbs and support rails in original packaging and protect from weather and construction traffic. Whenever possible, store indoors. Where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle roof curbs and support rails carefully to prevent damage, breaking, denting and scoring of finishes. Do not install damaged units or components; replace with new.

1.5 SEQUENCING AND SCHEDULING

A. Coordinate the installation of roof curbs, equipment supports and roof penetrations with the General Contractor.

B. Coordinate the size and location of structural steel support members.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide prefabricated roof curbs manufactured by one of the following:

1. Custom Curb, Inc.
2. Pate Co.
3. Roof Products & Systems Corp.
4. ThyCurb Div.; Thybar Corp.
5. Associated Rooftop Equipment Manufacturer

2.2 ROOF ACCESSORIES

A. Roof flashings for HVAC equipment are specified elsewhere in this Division of the Specifications.

2.3 ROOF EQUIPMENT, PIPING AND DUCT SUPPORTS

A. Fabricate roof curbs and roof support curbs from zinc-coated steel, ASTM A 146, Grade C, designation G90 hot-dip coating, mill phosphatized. Clean and paint with rust-inhibitive metal primer paint of type recommended by manufacturer, 2.0 mils dry film thickness.

B. Reinforce continuous runs of over 3'-0" length, by inserting welded stiffeners of heavy gauge with flanges as required to provide sufficient rigidity and strength to withstand maximum lateral forces in addition to superimposed vertical loads.

C. Fabricate curbs of minimum 18 gauge galvanized metal and to a minimum height above roof surface of 12".

D. Provide pressure treated wood nailer, not less than 1-5/8" thick and of width indicated, but not less than width of support wall assembly. Anchor nailer securely to top of metal frame unit. Wood shall be pressure treated with water-borne preservatives for "above ground" use, complying with AWPB LP-2.

E. Insulate curb's inside structural support wall with rigid glass fiber insulating board of approximately 3 lb. density and 1½" minimum thickness, except as otherwise indicated.

2.4 PIPING PENETRATION ROOF CURBS

A. All roof piping curbs shall be sealed watertight utilizing an ABS thermoplastic KORAD acrylic cover. Cover shall contain molded, graded boots of quantity and sizes to accommodate roof piping penetrations controls conduit and electrical conduit as indicated. Provide two (2) stainless steel pipe clamps per boot. Covers shall be as manufactured by the same manufacturer as roof curbs.

2.5 NON-INVASIVE SUPPORTS

A. Acceptable Manufacturers:

1. Furnish non-invasive supports as manufactured by one of the following acceptable manufacturers:

a. Miro

b. Erico

c. Cooper B-Line

d. Mifab

e. Rooftop Support Systems

B. Non-invasive pipe supports shall support piping above the roof with support not incorporated into the roofing system. Base shall be composed of crumb rubber with urethane binding agent compression molded on a hydraulic press. Fixing hardware shall be hot dip galvanized steel. “Roller Bearing” pipe supports shall be provided where indicated above.

PART 3 - EXECUTION

3.1 ROOFING WORK

A. Coordination

1. Coordinate the type of roofing materials and approved penetration methods with the General Contractor prior to making penetrations. Provide components and installation as specified below or as directed by the General Contractor.

2. The Mechanical Contractor shall locate all roof mounted equipment and roof penetrations. The General Contractor shall provide all roof openings and shall perform all roofing work required to incorporate roof curbs into roofing system.

B. Roof Curbs and Roof Equipment Supports

1. Where supports or curbs are not specified with mechanical equipment; provide prefabricated equipment supports or curbs for roof mounted equipment.

2. Where pipes penetrate the roof provide prefabricated pipe curb assemblies or pipe seals.

3. Coordinate requirements with the electrical contractor and controls contractor and provide openings in curbs to accommodate electrical and controls conduits.

END OF SECTION 23 07 11

SECTION 23 07 20
FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section specifies firestopping materials and installation requirements for the penetration of rated assemblies. Portions of this Section may not be required in this project. Actual field conditions, penetration type (pipe, duct, conduit, etc.) and assembly type, shall define exact firestopping requirements.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 QUALITY ASSURANCE

A. The firestop system installation shall be UL Listed and tested in accordance with ASTM E814.

B. Fire rating of the firestop system shall be equivalent to the assembly which is penetrated.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide firestopping as manufactured by one of the following:

1. Hilti, Inc.
2. 3M; Fire Protection Products Division.
3. Thermafiber Safing
4. Specified Technologies Inc.
5. FireTrak Corp.

2.2 MATERIALS

A. All products used under this Section shall be UL listed for the purpose.

B. Piping, ductwork, and sleeve penetrations of rated assemblies shall be sealed with the appropriate intumescent caulk, putty, strip, block, or sheet type fire barrier product.

C. Fire barrier products shall be installed in accordance with all U.L. System requirements for the type of penetration and firestopping system used. The following U.L. System descriptions are those of Hilti Inc. firestopping systems.

Table 23 07 20.1

Penetration (F rating)	UL System
Metal pipe through gypsum board (1 or 2 hour)	Hilti UL #WL1054 or approved equal
Metal pipe through masonry/concrete (2 hour)	Hilti UL #CAJ1291 or approved equal
Metal pipe through poured concrete floor slab (3 hour)	Hilti UL #FA1017 or approved equal
Insulated metal pipe through gypsum board (1 or 2 hour)	Hilti UL #WL5029 or approved equal
Insulated metal pipe through masonry/concrete (2 hour)	Hilti UL #CAJ5091 or approved equal
Insulated metal pipe through poured concrete floor slab (2 hour)	Hilti UL #FA5017 or approved equal
Plastic pipe through gypsum board (1 or 2 hour)	Hilti UL #WL2078 or approved equal
Plastic pipe through masonry/concrete (2 hour)	Hilti UL #CAJ2271 or approved equal
Plastic pipe through poured concrete floor slab (3 hour)	Hilti UL: #FA2054 or approved equal
Metal duct without fire damper through Gypsum board (1 or 2 hour)	Hilti UL #WL7040 OR #WL7042 or approved equal
Metal duct without fire damper through masonry/concrete (1 or 2 hour)	Hilti UL #WJ7021 OR #WJ7022 or approved equal

1. Actual project conditions may require a UL System not specifically described above. Fire barrier products manufacturer shall provide a UL System to meet actual project conditions

PART 3 - EXECUTION

3.1 GENERAL

A. All penetrations (pipe, duct, conduit, etc.) through fire rated assemblies shall be firestopped.

B. All firestopping materials shall be installed per the manufacturer's instructions.

C. Examine the areas and conditions where firestops are to be installed and notify the Engineer of conditions detrimental to the proper and timely completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected by the contractor in a manner acceptable to the Architect.

D. Unused sleeves or core drilled holes shall be plugged with fire resistant material and finished to match adjacent surfaces.

E. Finish surfaces of firestopping, which are to remain exposed to view, to a uniform and level condition.

F. Field Quality Control

1. All areas of work must be accessible until notification and inspection by the applicable Code authorities.

2. Have firestops examined by proper authorities to ensure proper installation and full compliance with this specification. If required, show proof of compliance by providing the appropriate UL firestopping system number.

3. Correct unacceptable firestops and provide additional inspection to verify compliance with this specification at no additional cost.

G. If requested, the Contractor shall show proof of compliance by providing the appropriate UL firestopping system number to the inspection Authority Having Jurisdiction or the Engineer.

END OF SECTION 23 07 20

SECTION 23 07 30
MISCELLANEOUS STEEL AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 21 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section describes the materials, fabrication, and installation requirements miscellaneous steel supports, structures, and reinforcements required for the proper installation of mechanical systems and equipment.

B. Furnish all material, equipment, labor, and supervision necessary to provide steel supports, structures, and reinforcements as required in by this division of the specifications and as called for on the drawings.

1.3 CODES AND STANDARDS

A. Design all miscellaneous steel in accordance with AISC Steel Handbook

1.4 SUBMITTALS

A. Equipment Support Structures

1. Submit fabrication drawings for each steel equipment support structure.

2. Include dimensions of structure, materials, material gauges or thicknesses, joining methods, and allowable support load ratings.

B. Piping Supports

1. Where pipes are commonly supported with miscellaneous steel, submit member sizing, material, material gauges and thicknesses, support method and building attachment methods and materials.

PART 2 - PRODUCTS

2.1 METALS

A. Metal Surfaces

1. General: Provide materials with smooth, flat surfaces without blemishes.

B. Ferrous Metals:

1. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

a. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.

2. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

3. Rolled-Stainless-Steel Floor Plate: ASTM A 793.

4. Abrasive-Surface Floor Plate: Steel plate [with abrasive granules rolled into surface] [or] [with abrasive material metallically bonded to steel by a proprietary process].

a. Products:

1). IKG Industries, a Harsco company; Mebac.

2). W. S. Molnar Company; SlipNOT.

5. Steel Tubing: ASTM A 500, cold-formed steel tubing.

6. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.

2.2 FASTENERS

A. General: Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.

B. Cast-in-Place Anchors in Concrete: Threaded or wedge type; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized per ASTM A 153/A 153M.

2.3 MISCELLANEOUS MATERIALS

A. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI #79.

B. Zinc-Rich Primer: Complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat.

1. Products:

a. Benjamin Moore & Co.; Epoxy Zinc-Rich Primer CM18/19.

b. Carboline Company; Carbozinc 621.

c. ICI Devoe Coatings; Catha-Coat 313.

d. International Coatings Limited; Interzinc 315 Epoxy Zinc-Rich Primer.

e. PPG Architectural Finishes, Inc.; Aquapon Zinc-Rich Primer 97-670.

f. Sherwin-Williams Company (The); Corothane I GalvaPac Zinc Primer.

g. Tnemec Company, Inc.; Tneme-Zinc 90-97.

2. Galvanizing Repair Paint: SSPC-Paint 20, high-zinc-dust-content paint for regalvanizing welds in steel.

3. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107.

2.4 FABRICATION

A. General: Preassemble items in the shop to greatest extent possible. Use connections that maintain structural value of joined pieces.

1. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.

2. Weld corners and seams continuously. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals. Obtain fusion without undercut or overlap. Remove welding flux immediately. Finish exposed welds smooth and blended.

3. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Locate joints where least conspicuous.

4. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

B. Miscellaneous Framing and Supports: Provide steel framing and supports not specified in other Sections as needed to complete the Work. Fabricate units from steel shapes, plates, and bars of welded construction. Cut, drill, and tap units to receive hardware, hangers, and similar items.

2.5 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Finish metal fabrications after assembly.

B. Steel and Iron Finishes:

1. Hot-dip galvanize items as indicated to comply with ASTM A 123/A 123M or ASTM A 153/A 153M as applicable.

2. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with requirements indicated below for environmental exposure conditions of installed metal fabrications:

a. Retain or revise first two subparagraphs below to suit Project service conditions of installed work. Insert other exposures and preparation requirements where applicable. Refer to SSPC's painting manual. Both subparagraphs apply to locations that would normally remain dry in service.

b. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

3. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."

a. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Furnish and install all miscellaneous steel for supports, structures, hangers, anchors, guides, etc., required for installation of equipment and material furnished and installed under this division.

B. General: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, with edges and surfaces level, plumb, and true.

1. Fit exposed connections accurately together. Weld connections that are not to be left as exposed joints but cannot be shop welded. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication.

2. Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction.

3. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

C. Delete three paragraphs and associated subparagraphs below not applicable to Project. Insert others where needed to specify requirements applicable to a specific item not covered under general installation requirements above.

D. Set bearing and leveling plates on cleaned surfaces using wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts and pack solidly with nonshrink, nonmetallic grout.

E. Touch up surfaces and finishes after erection.

1. Painted Surfaces: Clean field welds, bolted connections, and abraded areas and touch up paint with the same material as used for shop painting.

2. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 23 07 30

SECTION 23 08 10
VIBRATION ISOLATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies vibration isolation products and includes general description and installation methods.

B. Vibration isolation products furnished as an integral part of factory fabricated equipment are specified as part of the equipment in other sections of Division 23.

C. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 QUALITY ASSURANCE

A. Except as otherwise indicated; obtain vibration isolation products from a single manufacturer.

B. Engage manufacturer to provide proper selection and technical supervision of installation of vibration control products.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide isolators as manufactured by one of the following:

1. Amber Booth
2. Consolidated Kinetics Corp.
3. Flex-Hose Co.
4. Keflex
5. Korfund Dynamics Corp.
6. Mason Industries, Inc.
7. Metraflex
8. Peabody
9. Twin City Hose, Inc.
10. Vibration Eliminator Co.

2.2 GENERAL

A. Furnish and install vibration isolating mountings to isolate from the structure, by means of resilient vibration and noise isolators, all Mechanical Equipment having rotating or reciprocating parts. Isolators shall be supplied by a single source, and shall be guaranteed by the manufacturer to provide isolation efficiencies in accordance with this specification. Selection shall be based on equipment proposed, power dissipated, frequency, weight distribution and nature of the building structure.

B. Selection of the mountings shall be made of the manufacturer to provide a transmissibility not exceeding 10%.

C. Vibration or noise created in any part of the building by the operation of any equipment furnished and/or installed under this Contract shall be prohibited, and this Contractor shall take all precautions by isolating the various items of equipment, pipe and sheet metal work from the building structure. The major items of equipment shall be isolated as called for on the plans and specified herein. The minor items shall be held the responsibility of this Contractor.

D. Vibration isolators shall have either known undeflected heights or their markings so, after adjustment, when carrying their full load, the deflection under load can be verified, this determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided.

E. Size vibration isolators to operate in the linear portion of their load versus deflection curve. Furnish load versus deflection curves (linear over a deflection range 50 percent above the design deflection).

F. The ratio of lateral to vertical stiffness of vibration isolators shall not be less than 1.0 or greater than 2.0.

G. The vertical natural frequency for each support point based upon the load per isolator and isolator stiffness shall not differ by more than plus or minus 10 percent.

H. Shore hardness of neoprene mountings: 40 to 60 after minimum aging of 20 days or corresponding overaging.

I. Design or treat all isolators for resistance to corrosion. Structural steel bases shall be cleaned of welding slag and painted with a coat of red lead primer for interior use, and hot dip galvanized after fabrication for exterior use. All nuts, bolts and washers shall be zinc electroplated for interior use and hot dip galvanized for exterior use.

J. Select all mounts to perform their function without undue stress or overloading. All isolators that are to be used with structural steel bases shall be equipped with height saving brackets. The bottom of the brackets shall be 1-1/2 inches above the floor. Furnish isolators with a method of leveling and where spring isolators are used, provide gussets on both sides of the isolators or other structural reinforcement as required to prevent distortion.

K. Construct all structural steel bases with a minimum of four points of support. Structural steel bases: coped and fitted or constructed using the overlap insert method. Operating clearance of steel bases: at least 1-1/2 inches above the floor or housekeeping pad, clearance not to exceed 2-1/2 inches.

L. This Contractor shall provide concrete fill for pumps' inertia pads.

2.3 MECHANICAL EQUIPMENT ISOLATION

A. Ceiling suspended shall be suspended by threaded rods from the overhead structure with two inch deflection spring type vibration isolators at the mounting bracket. Mounting bracket with vibration isolators shall be furnished by the equipment manufacturer.

B. Ceiling fans shall be suspended from structure utilizing rubber type grommets on suspension hangers.

C. Connections from pump outlet and discharge nozzles to piping shall be made with flexible connectors.

1. Isolate each base mounted pump from the piping systems by use of pipe-size neoprene or EDPM ("rubber") type flexible connector couplings constructed of multiple piles of nylon and bias-ply tire cord reinforcing fabric with Control Cable and 150 psig ANSI steel flanges.

2. Isolate in-line pump support rods from building structure with rubber grommet type isolators. Install braided flexible pump connectors on inlet and discharge side of in-line pumps. Braided flexible pump connectors shall be constructed of stainless steel hose covered with stainless steel wire braid with NPT steel nipples or 150 psig ANSI flanges, welded to hose. Connectors shall be as manufactured by Flex-Hose Co., Metraflex or Twin City Hose, Inc.

D. Water chillers shall be mounted on precompressed molded fiberglass or rubber-in-shear isolation pads as recommended by the manufacturer. Pads shall be placed under the unit, on the roof equipment support rails. The isolators shall provide 90% isolation efficiency.

E. All floor supported piping and pipe hangers in the Mechanical Equipment rooms shall be mounted on steel spring vibration isolators in combination with precompressed molded fiberglass noise isolators, designed for minimum static deflections of 1".

F. Suspended piping entering or leaving base mounted pumps shall be supported for the first three hangers, from the overhead structure. The resilient hangers shall contain steel springs and precompressed molded fiberglass inserts, designed for static deflections between 1" and 1-3/4" under operating conditions.

G. Refrigerant piping supported from walls, hangers or structural steel shall be isolated utilizing rubber grommets.

H. Fans shall be supported independently of casings and ductwork with flexible canvass connections. Flexible canvas duct shall comply with NFPA 90A. Flexible connector shall be factory fabricated with fabric strip attached to 2 strips of 2-3/4 inch-wide, 0.028-inch-thick, galvanized-steel sheet.

1. Flexible connector fabric shall consist of glass fabric, double coated with neoprene. Fabrics, coatings, and adhesive shall comply with UL 181, Class 1.

a. Favric Minimum Weight: 26oz./sq.yd.

b. Fabric Tensile Strength: 480 ibf/inch in the warp and 360 ibf/inch in the filling.

c. Fabric Service Temperature: Minus 40 to plus 200°F.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which vibration control units are to be installed.

B. Do not proceed with work until satisfactory conditions have been corrected in manner acceptable to installer.

3.2 PERFORMANCE OF ISOLATORS

A. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's recommendations for selection and application of vibration isolation materials and units.

3.3 INSTALLATION

A. General: except as otherwise indicated, comply with manufacturer's instructions for installation and load application to vibration control materials and units. Adjust to ensure that units have equal deflection, no not bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices intended for temporary support during installation.

B. Adjust leveling devices as required to distributed loading uniformly onto isolators. Shim units as required where substrate in not level.

END OF SECTION 23 08 10

SECTION 23 10 10
COMMON PIPING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. The other Specifications of this Division complement the requirements of this Section.

C. For general Codes and Standards requirements refer to Section 23 00 20.

1.2 SCOPE

A. This Section specifies piping materials and installation methods common to more than one section of Division 23 and includes fittings, joining methods, and basic piping installation instructions.

B. Not all pipe materials and joining methods listed in this section pertain to this project. See specific system sections within this Division for approved materials and installation methods allowed to be used on this project.

C. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 QUALITY ASSURANCE

A. The installation of copper tubing in Hydronic systems shall conform to the requirements of the ICC International Mechanical Code and the Ohio Mechanical Code.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code – Steel."

C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be supplied by the same manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components.

E. All grooved couplings shall be installed strictly according to grooved manufacturer's instructions including torque verification and specific lubrication as published.

F. All piping materials, valves, fittings, joints, etc. shall be manufactured in the United States of America.

G. Installer Qualifications:

1. Press Fitting Installers: Installers of press fitting joints shall be certified by the manufacturer as having been trained and qualified and licensed within the jurisdiction for the installation of copper press joint systems.

H. Copper press fittings shall be installed using the proper tool, actuator, jaws and rings as instructed by the press fitting manufacturer.

1.4 CODES AND STANDARDS

A. ASME Compliance:

1. Comply with ASME B31.1, “Power Piping” and ASME B31.9, “Building Services Piping” for materials, products, and installation.

B. All welding and brazing shall be in accordance with the Ohio Administrative Code (OAC) 4101:8-15 "Welding and Brazing" and Section IX of the ASME "Boiler and Pressure Vessel Code".

C. All pressure piping systems shall be installed in accordance with the OAC 4101:8 "Pressure Piping System Rules".

D. All mechanical piping systems shall be installed in accordance with the Local Mechanical Code.

E. All refrigeration systems shall be installed in accordance with the Local Mechanical Code and the Safety Code for Mechanical Refrigeration (ANSI B9.1) and ASME B31.5.

F. All refrigeration systems shall comply with UL 207 Refrigerant Containing Components and Accessories.

PART 2 - PRODUCTS

2.1 GENERAL

A. Piping Materials

1. Refer to individual system specification sections for allowable locations for each piping material, fitting style, and joining method. The following materials and joining may not be acceptable for certain projects and in certain areas.

2. Provide pipe of type, joint type, grade, size and weight (wall thickness or class) as is indicated for each service in other Division 23 sections of this specification.

3. Where type, grade or class is not indicated, provide proper selection as determined by installer for installation requirements, and comply with governing regulations and industry standards.

2.2 PIPE FITTINGS

A. General

1. Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size.

2. Provide sizes and types of matching pipe, valve or equipment connections in each case.

3. Where not otherwise indicated, comply with governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable.

B. Joining Materials

1. Soldering Materials: Surfaces to be soldered shall be cleaned, properly fluxed and soldered with 95-5 tin-antimony solder. 50-50 and all other lead-bearing solders ate prohibited.

2. Gaskets For Flanged Joints: Select materials and types to suit the service of the piping system in which they are installed. Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

3. Gaskets For Mechanical Couplings: Select materials to suit the service of the piping system in which they are installed. Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.3 COPPER PIPE AND FITTINGS

A. Type K Soft Copper: ASTM B 88 water tube, annealed temper

B. Type L Hard Copper: ASTM B 88 water tube, drawn temper

C. Type ACR Hard Drawn Seamless Copper Tube: ASTM B 819

D. Copper, Solder-Joint Fittings:

1. ASME B16.22, wrought-copper, brazed or solder-joint pressure type.

E. Copper, Pressure-Seal Fittings:

1. Press Fittings: Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed.

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

a. Elkart

b. Nibco

c. Viega; Plumbing & Heating Systems (Pro-Press).

3. NPS 2 and Smaller:

a. Wrought-copper fitting with EPDM O-ring seal in each end.

4. NPS 2-1/2 to NPS 4

a. Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

F. Copper, Grooved-Joint:

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

a. Anvil International.

b. Victaulic Company.

2. Copper Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.

3. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

2.4 BLACK STEEL PIPE AND FITTINGS

A. Pipe Materials shall conform to the following standards:

1. Steel Pipe, NPS 2-1/2" and Smaller: ASTM A 53, Type S (seamless) or, Grade B, Schedule 40 or 80, black steel, plain ends, with threaded joints per ANSI B16.4.

2. Steel Pipe, NPS 3 through NPS 12: ASTM A 53, Type E (electric-resistance welded), Grade B, Schedule 40, black steel, plain ends.

B. Black Steel, Threaded:

1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53 or ASTM A 106, Schedule 40, seamless steel pipe. For NPS 2" and smaller and electric-resistance welded for NPS 2-1/2" and larger.

2. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.

3. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.

4. Malleable-Iron Unions: ASME B16.39; Classes 150, 250 and 300.

C. Steel Flanges:

1. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125 and 250; raised ground face, and bolt holes spot faced.

2. Wrought-Steel Fittings: Welding neck type, ASTM A 234/A 234M, wall thickness to match adjoining pipe.

3. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: Welding neck type, ASME B16.5, including bolts, nuts, and gaskets.

D. Black Steel, Welded:

1. Schedule 40 Factory Formed, Conforming with ASME B16.

2. Flanges: ASME B16.1, Class 125, cast iron.

E. Black Steel, Grooved-Joint:

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

a. Anvil International.

b. Victaulic Company.

2. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.

3. Grooved-End, Ductile-Iron-Pipe Couplings: AWWA C606 for ductile-iron-pipe dimensions. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

2.5 PVC PIPE AND FITTINGS

A. PVC Socket Fittings: ASTM D 2665, socket type.

2.6 CPVC PIPE AND FITTINGS

A. CPVC Pipe: ASTM F 441.

B. CPVC Socket Fittings: ASTM F 438 for Schedule 40 and ASTM F 439 for Schedule 80.

2.7 PEX TUBING AND FITTINGS

A. PEX Distribution System: ASTM F 877, SDR 9 tubing.

2.8 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Acceptable Manufacturers:

a. Eslon Thermoplastics.

B. Plastic-to-Metal Transition Unions: MSS SP-107, PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

1. Acceptable Manufacturers:

a. NIBCO INC.

b. NIBCO, Inc.; Chemtrol Div.

2.9 DIELECTRIC TRANSITION FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: **Dielectric Unions are not allowed.**

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

1. Acceptable Manufacturers:

a. Capitol Manufacturing Co.

b. Central Plastics Company.

c. Epco Sales, Inc.

d. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Acceptable Manufacturers:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Central Plastics Company.

d. Pipeline Seal and Insulator, Inc.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Acceptable Manufacturers:

a. Calpico, Inc.

b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Acceptable Manufacturers:

a. Perfection Corp.

b. Precision Plumbing Products, Inc.

c. Sioux Chief Manufacturing Co., Inc.

d. Victaulic Co. of America.

2.10 JOINING MATERIALS AND METHODS

A. Grooved: Roll grooved joints per coupling manufacturer's specifications.

B. Pressed: Pressed joints per manufacturer's recommendations, using tool designed and approved specifically for use with fittings.

C. Threaded: Pipe threads shall conform to ASME B1.20.1.

D. Welding: Comply with ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

E. Pipe-Flange Gasket Materials: Select materials and types to suit the service of the piping system in which they are installed. Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

F. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

G. Plastic, Pipe-Flange Gasket, Bolts, and Nuts:

1. Type and material recommended by piping system manufacturer, unless otherwise indicated.

H. Solder Filler Metals:

1. Surfaces to be soldered shall be cleaned, properly fluxed and soldered with 95-5 tine-antimony solder. 50-50 and all other lead-bearing solders are prohibited.

2. ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813. 50-50 and all other lead-bearing solders are prohibited.

I. Brazing Filler Metals:

1. Comply with ASME Boiler and Pressure Vessel Code for brazing filler metal materials appropriate for the materials being jointed. Silver brazing alloy shall ave a melting point above 1000° F.

2. AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated

3. AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

J. Welding Filler Metals:

1. Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

K. Gaskets for Mechanical Couplings:

1. Select materials to suit the service of the piping system in which they are installed. Provide materials that will not be detrimentally affected by the chemicals and thermal conditions of the fluid being carried. Gaskets for Hydronic piping shall be EHP or EPDM, suitable for -30° F to 230° F temperature range.

L. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.

2. CPVC Piping: ASTM F 493.

3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

4. PVC to ABS Piping Transition: ASTM D 3138.

2.11 UNIONS AND FLANGES

A. All unions and flanges shall be suitable for the temperature/pressure ratings and service in which installed. See each specific system description section of Division 32 for additional information.

Table 23 10 10.1

Pipe Material	Size	Description
Steel	2" and smaller	Malleable iron, threaded ends, ground joint brass to iron seat
	2-1/2" and larger	Weld-neck flange connections
Copper	2" and smaller	Cast brass solder ends, with machined and lapped seats
	2-1/2" and larger	Flange connections

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. Provide factory-applied plastic end-caps on each length of pipe and tube. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris and moisture.

B. Protect Stored Pipes: Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor or structure.

C. Protect flanges, fittings and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

3.2 GENERAL PIPING INSTALLATION REQUIREMENTS

A. The Drawings indicate the general location and arrangement of the piping systems. So far as practical, install piping as indicated making connections to all equipment.

B. Install piping as direct as possible avoiding unnecessary offsets. However, if offsets are required in order to obtain maximum headroom or to avoid conflict with other work, they shall be made as required or as requested by the Architect without additional cost to the Owner. The Architect reserves the right to make minor changes in the location of piping and equipment during the roughing-in, without additional cost to the Owner. All changes proposed by others shall be approved by the Architect.

C. Install piping, requiring insulation, a sufficient distance from wall, ceiling, structure, other pipes, etc. to permit the application of the full thickness of insulation specified.

D. Install piping free of sags or bends.

E. Where piping is installed above accessible ceilings, allow sufficient space between ceiling and pipe to remove ceiling panels. Consideration must be given for insulation thickness.

F. Locate piping installed parallel to each other with adequate space for servicing of valves where applicable.

G. Any piping resting on or coming in contact with building structure shall be insulated at that point to prevent transmission of vibration.

H. All piping shall be installed parallel with, or at right angles to, the building walls. All vertical risers shall be installed plumb and straight. Diagonal runs are not permitted unless expressly indicated on the drawings.

I. Install all piping with reduction in size being made only at the inlet and outlet of control valves, regulating valves and equipment.

J. Make reductions in piping with a reducing coupling or weld fitting reducer. Bushings are not permitted.

K. Factory formed long radius elbows shall be utilized for all changes in direction. Mitering of pipe to form elbows is not permitted. Pipe bending is not acceptable.

L. Make branch connections in threaded or soldered piping with factory formed fittings.

M. Make branch connections in welded steel piping less than 2/3 of main size with weldolets or threadolets. Make branch connections 2/3 of main size or larger with weld tees. Notching of straight runs of pipe to form tee connections is not permitted.

N. Taps shall be provided as necessary to permit the installation of control devices, thermometers, pressure gauges, air vents, etc. Taps shall be similar to branch connections.

O. Pipe relief valve discharges, etc. down to the floor or nearest floor drain where indicated. Drain piping shall terminate with a plain, unthreaded end.

P. Install dielectric waterway fittings wherever pipe of different metal is connected. Dielectric unions are not permitted. Brass valves shall not be utilized for dielectric separation.

Q. Bullhead connections in any piping system are prohibited.

R. Schedule 80 PVC installation shall comply with the latest installation instructions published by pipe manufacturer and shall conform to all local code requirements. Solvent cement joints shall be made in a two step process with primer manufactured for thermoplastic piping systems and solvent cement conforming to ASTM D 2564.

3.3 HANGING AND SUPPORT

A. Support piping independently so as not to place a strain on valves and equipment.

B. See Section 23 12 20 - Piping Hangers and Supports for more details.

3.4 JOINTS

A. After cutting, ream ends of piping and remove all burrs. Remove all scale, slag dirt and debris from both inside and outside of piping and fittings before assembly. Swab if necessary for thorough cleaning.

B. Pipe to be threaded shall be cut square and fully threaded with tapering threads. Apply pipe joint compound to male thread end of all threaded joints. Joint compound shall be compatible with the service of the piping.

C. The edges of pipe to be welded shall be machine beveled wherever possible. Before welding, the surfaces shall be thoroughly cleaned. The piping shall be carefully aligned. No metal shall project within the pipe.

3.5 EXPANSION

A. Piping shall be cut accurately to measurement at the site and worked into place without springing or forcing. Sufficient offsets, expansion loops or expansion joints between anchor points shall be provided as required, whether or not shown, to limit stresses and control movement of piping subject to the thermal expansion.

B. Supplement all loops, joints, compensators, etc. with adequate guides to preserve alignment and pitch.

C. Securely attach pipe guides to the building structure.

D. Anchor piping to ensure proper direction of expansion and contraction. Provide expansion loops or joints as indicated or as required to control expansion and contraction.

E. See Section 23 18 20 for additional requirements.

3.6 ESCUTCHEONS

A. Fit all pipe passing exposed to view through walls, floors or ceilings in finished rooms with brass escutcheons. Where adjacent surface is to receive a paint finish, prime paint escutcheons, otherwise escutcheons shall be chrome plated. Where piping is insulated, fit escutcheons outside insulation. Pipes penetrating mechanical room walls do not require escutcheons.

3.7 CLEANING

A. After piping installation is complete and before final connections to equipment are made, thoroughly flush the piping system with a material/detergent that is not injurious to the pipe, to remove all pipe dope, oils, welding slag, scale and other extraneous material.

B. After flushing, clean all strainers, traps and dirt legs.

C. See each specific system description section of Division 23 for additional cleaning requirements.

END OF SECTION 23 10 10

SECTION 23 10 20
HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. The other Specifications of this Division complement the requirements of this Section.

C. Refer to Section 23 10 10 for Common Piping Requirements.

1.2 SCOPE

A. This Section specifies piping materials and installation methods for hydronic system piping and includes fittings, joining methods and specific piping installation instructions.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

C. See drawings and each specific system description indicated herein for specific sizes, materials and installation methods pertaining to this project. Portions of this Section may not be required for this project.

1.3 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Sections 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 GENERAL

A. All piping shall be constructed of materials and joined together as specified in the following sections.

B. Material specifications are contained in Section 23 10 10 - Common Piping Requirements.

2.2 PIPE AND FITTING TABLE

A. The table below identifies the acceptable pipe materials, fitting types, and joint methods allowed for each pipe service and size.

B. Pipe schedules refer to ANSI B36.

C. Pipe sizes refer to Nominal Pipe Sizing (NPS) standards.

D. Where more than one pipe material, fitting type, or joint method is indicated for the same system type; it shall be the installing contractor's choice to determine which type shall be utilized.

Table 23 10 20.1

Service	Size	Pipe Material	Fittings	Joint Method*
Coil Condensate Drain	All Sizes	Type L Copper	Wrought Copper	S
				P
		Schedule 40 PVC	Factory Formed	C

			schedule 40 PVC	
Heating Water	2” and smaller	Schedule 40 Black Steel	125 lb. cast iron	T
		Type L Hard Copper	Wrought copper	S
		Type L Hard Copper	Wrought copper	P
	2-1/2” to 10”	Schedule 40 Black Steel, ASTM A53, Type E, Grade A	Schedule 40 Factory Formed	W
	2-1/2” to 10”	Schedule 40 Black Steel, ASTM A53, Type E, Grade A	Schedule 40 Factory Formed with factory grooved ends	G
*Joint Methods: B=Brazed, C=Solvent Cement, G=Grooved, P=Pressed, S=Soldered, T=Threaded, W=Welded				

PART 3 - EXECUTION

3.1 INSTALLATION

A. All hydronic piping systems must be installed so it can be completely drained. Provide tee fitting, ball valve with hose thread fitting and cap at all low points, trapped sections, bases of risers, and on equipment side of shut off valves to permit draining. Provide ball valves at all high points to allow venting. All drain valves and vents shall be accessible. All air vent valves shall have a 3/8" soft copper discharge tube elbowed downward, away from pipe and pipe insulation.

B. Make branch connections to mains for heating risers and heating equipment with at least two (2) 90 degree elbows.

C. Installation shall conform to Section 23 10 10 - Common Piping Requirements.

3.2 CLEANING AND TESTING

A. Comply with requirements in Section 23 03 10.

END OF SECTION 23 10 20

SECTION 23 10 40
REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. The other Specifications of this Division complement the requirements of this Section.

C. Refer to 23 10 10 for Common Piping Requirements.

1.2 SCOPE

A. This Section specifies piping materials and installation methods for refrigerant piping systems. See drawings and each specific system description indicated herein for specific sizes, materials and installation methods pertaining to this project.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Sections 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 GENERAL

A. All piping shall be constructed of materials and joined together as specified in the following sections.

B. Material specifications are contained in Section 23 10 10.

2.2 PIPE AND FITTING TABLE

A. The table below indentifies the acceptable pipe materials, fitting types, and joint methods allowed for each pipe service and size. Where multiple options are listed, the option used shall be at the discretion of the Contractor.

Table 23 10 40.1

Service	Size	Pipe Material	Fittings	Joint Method*
Refrigerant Liquid	All Sizes	Type L- ACR Hard Drawn Seamless Copper Tube	Wrought Copper	B
Refrigerant Liquid	1-5/8" and smaller	Type L Soft Annealed Copper Line Set	Flared	M
Refrigerant Suction	All Sizes	Type L-ACR Hard Drawn Seamless Copper Tube	Wrought Copper	B
Refrigerant Suction	1-5/8" and smaller	Type L Soft Annealed Copper Line Set	Flared	M
*Joint Methods: B=Brazed, M=Mechanical				

B. All ACR tubing and line sets shall be shipped with a sealed holding charge of nitrogen.

2.3 REFRIGERANT SPECIALTIES

A. Filter-Drier: Steel shell, steel flange ring, steel spring, ductile iron cover plate with steel capscrews, wrought copper solder ends, 500 psig operating pressure. Furnish complete with replaceable filter-drier core kit, including gaskets and standard capacity desiccant sieves to provide micronic filtration.

B. Sight Glass: Forged brass body, replaceable polished optical viewing window, solder ends, 500 psig operating pressure, and 200 °F operating temperature.

C. Flexible Connectors: Seamless tin bronze or stainless steel core, high tensile bronze braid covering with synthetic covering, factory pressure tested, minimum 7 inch length, solder ends, 500 psig operating pressure.

2.4 REFRIGERANT

A. Refrigerant in accordance with ASHRAE Standards – see equipment schedules for required refrigerants.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide filter/drier assemblies, moisture indicators, thermal expansion valve and solenoid valves for each refrigeration circuit.

B. Piping and specialties shall be sized to prevent excessive pressure drop and allow compressors and evaporators to operate together with balance points at or above the specified capacities.

C. Piping and specialties shall be arranged to return oil at all loads and prevent liquid from "slugging" the compressor or siphoning to the evaporator. Provide double suction risers and traps as required.

D. Refrigerant piping shall be cut with a tube cutter only and shall be reamed after cutting. Hack saw cuts are prohibited.

E. Pitch horizontal refrigerant piping 1/2 inch per 10 feet in direction of flow.

F. Provide separate refrigerant circuits for multiple compressor applications.

G. All refrigerant piping shall be assembled with brazed joints. Continuously purge joints while being brazed with oil-free dry nitrogen to prevent the formation of scale within the tubing. Copper to copper refrigerant piping joints shall be made using a phosphorus bearing alloy such as “Sil-Phos” without flux. Copper to brass and copper to steel joints shall be made using a 45% silver alloy such as “Easy-Flo” with flux.

H. Install strainers immediately ahead of each thermostatic expansion valve, solenoid valve and as required to protect refrigeration piping system components.

I. Install unions to allow removal of thermostatic expansion valves and solenoid valves and at connections to compressors and evaporators.

J. Install flexible connectors at the inlet and discharge connections of compressors.

K. Install pressure regulating and relieving valves as required by ASHRAE Standard 15 and the Safety Code for Mechanical Refrigeration (ANSI B9.1).

L. Refrigerant system piping layout and sizing shall be approved by the equipment manufacturer and engineer.

M. Packaged soft refrigerant piping systems may be utilized for individual refrigeration systems of five ton capacity or smaller. Packaged refrigerant piping systems shall be cleaned and sealed. Packaged piping systems shall remain sealed until immediately before installation.

3.2 TESTING

A. Test refrigerant piping with oil-free pumped dry nitrogen. Twenty four hour standing time minimum. Tests shall conform to "Pressure Piping Code" 4101:8-3 and ANSI Standard B31.5 "Refrigerant Piping".

B. Refer to the table below for required test pressures:

Table 23 10 40.2

Type	Line Type	Pressure (psig)
R-134a	Suction Lines for Air-Conditioning Applications	115
	Suction Lines for Heat-Pump Applications	225
	Hot-Gas and Liquid Lines	225
R-407C	Suction Lines for Air-Conditioning Applications	230
	Suction Lines for Heat-Pump Applications	380
	Hot-Gas and Liquid Lines	380
R-410A	Suction Lines for Air-Conditioning Applications	300
	Suction Lines for Heat-Pump Applications	535
	Hot-Gas and Liquid Lines	535

General Notes:
1. Test piping with oil-free pumped dry nitrogen
2. Test duration shall be 24 hours.
3. Test Per Pressure Piping Code 4101:8-3 and ANSI Standard B31.5

C. After the test pressure has been applied for the required time period, examine the system for leakage. All joints must then be thoroughly leak tested using either an electronic leak detector, a halide torch or soap bubbles. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat tests until there are no leaks.

3.3 CHARGING

A. After the refrigerant piping has been leak checked, the entire piping system shall be evacuated using the triple evacuation method or an appropriate method as recommended by the equipment manufacturer. Piping shall be drawn successively to 1,500 microns, 1,500 microns and 500 microns of vacuum. The vacuum should be broken each time using system refrigerant. After evacuation, the system shall be charged with the proper amount of refrigerant for designed operation.

END OF SECTION 23 10 40

SECTION 23 11 10
PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies piping insulation materials and installation methods common to more than one section of Division 23.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all insulation work described in this Section.

1.3 CODES AND STANDARDS

A. Provide all insulation materials (insulation, jackets, fitting covers, adhesives, cements, mastics, sealers and finishes) with a flame-spread index of 25 or less and smoke developed index of 50 or less, as tested under procedure ASTM E-84 (NFPA 255).

1.4 QUALITY ASSURANCE

A. Installing contractor shall have at least 3 years successful installation experience on projects with mechanical insulation similar to that required for this project.

B. Insulation thickness shall meet the requirements of ASHRAE Standard 90.1.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Sections 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Unless otherwise noted, and subject to compliance with Specifications, provide insulation materials from the manufacturers specified below:

1. Fiberglass Pipe Insulation
    a. CertainTeed Corp.
    b. Johns Manville
    c. Knauf Insulation
    d. Owens Corning
2. Closed Cell Elastomeric Pipe Insulation
    a. Armaflex
    b. Aeroflex
    c. Insul-Tube

d. K-Flex USA

e. Manson Insulation

f. Nomaco Kflex

g. Techlite Insulation

h. Thermacel

2.2 GENERAL

A. Provide all insulation materials (insulation, jackets, fitting covers, adhesives, cements, mastics, sealers and finishes) with a flame-spread index of 25 or less and smoke developed index of 50 or less, as tested under procedure ASTM E-84 (NFPA 255).

2.3 FIBERGLASS

A. Provide one-piece fiberglass pipe insulation with all-service jacket for all piping systems indicated on drawings or in other sections of this Specification.

B. Fiberglass pipe insulation shall have a "k" factor of 0.23 at a mean temperature of 75 °F.

C. Fiberglass pipe insulation shall comply with ASTM C 547 Type I.

D. Factory applied all service jacket shall be white, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

E. Provide fiberglass pipe insulation in accordance with the following:

Table 23 11 10.1

Pipe Type	0 to 1"	1-1/4" to 2"	2-1/2" to 4"	5" and 6"	8" and above
Cooling Coil Condensate Drain Piping (not in units)	1/2”	1”	1”	1”	1”
Heating Hot Water Piping	1”	1-1/2”	1-1/2”	1-1/2”	1-1/2”
Make-up Water Piping	1”	1”	1”	1”	1”

2.4 CLOSED CELL ELASTOMERIC INSULATION

A. Provide closed-cell elastomeric pipe insulation for all piping systems indicated on drawings or in other sections of this Specification.

B. Closed cell elastomeric pipe insulation shall comply with ASTM C 534 Type I.

C. Apply the following insulation thickness schedule to the pipe size and type:

Table 23 11 10.2

Pipe Type	0 to 1"	1-1/4" to 2"	2-1/2" to 4"	5" and 6"	8" and above
Air Conditioning Condensate Drain Piping (within unit cabinet)	1/2"	1"	1"	-	-
Refrigerant Liquid Piping (Ductless, VRF and Heat Pump systems)	1/2"	1"	1"	1"	1-1/2"

2.5 PVC JACKETS

A. PVC jacket shall be high-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C.

2.6 ALUMINUM JACKETS

A. Jacket shall be 0.016" thick sheet aluminum.

2.7 OUTDOOR PIPING WATERPROOF MEMBRANE

A. Waterproofing membrane shall consist of sheet-type, pre-fabricated, self-adhering, UV-resistant products. Waterproof membrane shall be as manufactured by MFM Building Products Corp., (Flexclad 400) or by Venture Tape Corp. (VentrueClad 1577).

2.8 ADHESIVES

A. Adhesive shall have UL classification and be non-flammable.

B. Adhesives for Fiberglass: MIL-A-3316C, Classes 1 and 2, Grade A.

C. Adhesives for Elastomerics: MIL-A-24179A, Type II, Class 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. On exposed piping, locate insulation and cover seams in least visible locations.

B. Install piping insulation continuous through all wall, floor and ceiling penetrations, sleeves and pipe hanger locations.

C. Install fiberglass pipe insulation with joints butted firmly together. Seal jacket laps with butt strips, having factory applied adhesives. **Insulate valves and fittings using mitered sections of insulation or premolded fitting insulation**. Cover valves and fittings with the same type and density of insulation as used on the piping. Do not cover valve bonnets, unions and strainers with insulation except for chilled water and domestic cold water piping systems.

D. Taper all insulation ends, seal and cover with glass cloth regardless of service. Where vapor barrier jackets are used on cold surfaces, apply insulation with vapor seal integrity maintained throughout the entire system. Staples shall not be used on any cold piping systems.

E. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints. For cold piping, apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3" wide vapor barrier tape or band.

F. Apply the manufacturer's recommended adhesive for closed-cell elastomeric pipe and sheet insulation based on the working temperature of service.

G. Insulate all valves and fittings to match adjacent piping.

3.2 JACKET LOCATIONS

A. Interior:

1. All interior piping fittings shall have molded PVC fitting covers.

2. All piping that is installed exposed to view in habitable spaces shall receive a PVC jacket up to above the space’s ceiling. In spaces with no ceiling, install up to 8 feet above floor.

3. Provide aluminum on interior pipe risers exposed to view in habitable spaces up to 8 feet above floor.

4. Provide PVC jacket on all piping in kitchen areas that are exposed to view.

B. Exterior – Closed Cell Elastomeric Insulation:

1. Install UV resistant PVC jackets on all exterior piping with weatherproof membrane (refer to part 2). The entire assembly shall be weatherproof and installed per manufacturer’s recommendations.

C. Exterior – Fiberglass Insulation:

1. Cover with an aluminum jacket in addition to the normal finish, unless noted otherwise on the drawings.
2. A two-inch lap is required at all longitudinal and circumferential joints.
3. Longitudinal joints shall be located at the 3 or 9 o'clock position on the side of horizontal piping with 2" overlap facing down to shed water.
4. Bands shall be 3/4" wide aluminum installed 18" on-center. The entire assembly shall be weatherproof.

3.3 DELIVERY, STORAGE AND HANDLING

A. Deliver insulation, coverings, cements, adhesives and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.

B. Protect insulation against dirt, water, chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

C. Replace damaged insulation which cannot be satisfactorily repaired, including insulating with vapor barrier damage and moisture-saturated insulation.

D. The insulation installer shall advise the Architect, Construction Manager and General Contractor as to requirements for protection of the insulation work during the remainder of the construction period (after the installation of insulation), to avoid damage and deterioration of the finished insulation work.

END OF SECTION 23 11 10

SECTION 23 12 10
PIPING IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies piping identification and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. All pipe markers shall conform to ANSI A13.1 "Scheme for the Identification of Piping Systems".

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Sections 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

C. Schedules: Submit valve schedule for each piping system. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space) and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses by special “flags” in margin if schedule. After review and approval of valve schedule, furnish extra laminated copies for Maintenance Manuals as specified in Division 1. Valve numbering sequence shall follow the format of the Owner’s existing system.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide identification as manufactured by one of the following:

1. Brady Corp.
2. Brimar Industries, Inc.
3. Craftmark Identification Systems.
4. DuraLabel/Graphic Products
5. Identification Depot
6. Kolbi Pipe Marker Co.
7. Marking Services, Inc.
8. Seton Identification Products.

2.2 PIPE MARKERS

A. Colored, precoiled plastic, designed to install without the need for tape or a band. Markers to include flow direction arrows and lettering describing pipe's contents. Markers shall provide 360° visibility.

B. Markers for installation on piping with outside diameter less than 6" (including insulation) shall be snap-around type. Markers for installation on piping with outside diameter 6" or greater (including insulation) shall be strap-around type.

C. Marker colors shall be based on hazard levels of material contained in piping. Note – medical gas markers do not conform to this requirement.

Table 23 12 10.1

Hazard Type	Color Scheme
High Hazard	Yellow with black letters
Low Hazard Gas	Blue with white letters
Low Hazard Liquid	Green with white letters

D. Marker colors and wording for each specific piping system shall be as follows:

Table 23 12 10.2

Marker Wording	Background/Lettering
Chilled Water Return	Green/White
Chilled Water Supply	Green/White
Compressed Air	Blue/White
Condenser Water Return	Green/White
Condenser Water Supply	Green/White
Control Air (20 psig)	Blue/White
Fuel Oil Return	Yellow/Black
Fuel Oil Supply	Yellow/Black
Glycol Chilled Water Return	Green/White
Glycol Chilled Water Supply	Green/White
Heating Water Return	Yellow/Black
Heating Water Supply	Yellow/Black
High Pressure Condensate	Yellow/Black
High Pressure Steam	Yellow/Black
Low Pressure Condensate	Yellow/Black
Low Pressure Steam	Yellow/Black
Makeup Water	Green/White
Medium Pressure Condensate	Yellow/Black
Medium Pressure Steam	Yellow/Black
Refrigerant Piping*	Yellow/Black
* indicate liquid, suction, or hot gas	

2.3 VALVE TAGS

A. Brass valve tags, 1-1/2" diameter round with black fill letters and numbers. 19 gauge brass with 3/16" top hole.

B. Valve tags shall have a 1/4" high "HVAC" label.

C. Each system shall be consecutively numbered, starting with "1", with 1/2" high numbers.

D. Valve tags shall be attached to each valve with a non-rusting ring or chain.

E. Valve Location Tags: ¾” diameter colored, pressure-sensitive adhesive paper circles.

2.4 CEILING MARKERS

A. Ceiling markers shall be provided for mechanical devices concealed above ceilings, including all shut off valves.

B. Ceiling markers shall be 1" diameter white sticky tags with ¼" black lettering.

C. Markers for valves shall match the valve tag schedule with the system abbreviation.

D. Ceiling markers shall be worded as follows:

1. Valves – HWS-xxx, where "HWS" is the abbreviated piping system – heating water supply, and xxx is the number from the valve tag schedule.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in mechanical identification work with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated in coordination with the Owner or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.

3.3 PIPE MARKER INSTALLATION

A. Install pipe markers at the following locations:

1. Adjacent to valves.
2. Where pipes pass through walls, on both sides of wall.
3. Where pipes pass through floor, above floor, within two feet of floor level.
4. Near all branches and changes in direction.
5. At 20 foot intervals on straight runs of pipe.
6. At access door locations.

3.4 VALVE TAG INSTALLATION

A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude valves within factory-fabricated equipment units and similar rough-in connections of end-use individual terminal units. Branch line shut off valves that serve less than five (5) terminal units, need not be tagged. List each tagged valve in valve schedule for each piping system.

B. All shut-off and balancing valves shall be tagged except local valves adjacent to an equipment item. (Exclude valves that serve individual terminal units).

C. At the completion of the project, provide a valve directory for each system. Include a copy of each directory in the Operating and Maintenance Manual. Coordinate the valve designation/numbering system with the Owner. Directory shall include valve designation/number, service, building location, size and equipment/fixtures controlled.

D. Accurately record valve tag numbers and locations on the "Record Drawings".

3.5 VALVE CHARTS

A. Valve charts shall include the following items:

1. Valve identification
2. Location
3. Purpose

3.6 CEILING MARKERS INSTALLATION

A. Ceiling markers shall be located in close proximity to the device it tags. Ceiling markers shall be installed on the tee bars of layin ceilings, but not on the main runs.

END OF SECTION 23 12 10

SECTION 23 12 20
PIPING HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies piping hanging and supporting methods common to more than one section of Division 23 and includes hangers, supports, saddles, shields, clamps, inserts, and miscellaneous materials necessary for the proper hanging and supporting of piping systems. Portions of this Section may not be required in this project. See drawings and each specific system description section of Division 23 for specific sizes; materials and installation methods pertaining to this project.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. All mechanical system piping shall be supported in accordance with the Local Mechanical Code.

B. Hangers and supports shall comply with ANSI/Manufacturer's Standardization Society (MSS) SP-58, SP-69 and SP-89. Terminology used in this section is defined in MSS SP-90.

1.4 QUALITY ASSURANCE

A. Qualifying welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code – Steel."

1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

B. Qualify welding processes and welding operators in accordance with ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with these specifications, pipe hanger and support systems shall be as manufactured by one of the following:

1. ANVIL
2. ELCEN
3. ERICO, Inc.

4. Fee and Mason
5. Grinnell
6. Hydra-Zorb Company
7. MetraFlex
8. PHD Manufacturing Inc.
9. Pipe Shields

2.2 PIPE HANGERS AND SUPPORTS

A. All hangers, brackets, clamps, etc., shall be of standard weight galvanized steel. Perforated strap hangers shall not be used in any work. **Each hanger is to be sized to include pipe insulation**.

B. All model numbers referenced within this specification are as manufactured by Erico.

C. When two or more pipes are run parallel, they may be supported on Unistrut type trapeze hangers. Insulation on insulated pipe shall be continuous at trapeze hangers. At each trapeze hanger provide a minimum 12" long insulation protection shield, Model 126 or 127 with 180° calcium silicate or hardwood shield insert; thickness shall match thickness of insulation.

D. In general, support individual horizontal piping as follows:

Table 23 12 20.1

Pipe Description	Pipe Size	Hanger Description
Uninsulated steel and plastic piping	2” and smaller	Model 100 heavy duty galvanized steel swivel loop hanger
	2-1/2” and larger	Model 400 carbon steel clevis hanger.
Uninsulated copper piping	2” and smaller	Model 101 copper plated steel swivel loop hanger
	2-1/2” and larger	Model 402 copper plated steel clevis hanger
Insulated piping (hot or cold)	2" and smaller	Model 403 or 4031 carbon steel clevis hanger for insulated pipe with insulation protection shield. Install with 180° calcium silicate shield insert (thickness to match adjacent pipe insulation). Insulation vapor barrier to be continuous at each hanger
Insulated hot piping	2-1/2” and larger	Model 610 steel one rod roller hanger with carbon steel pipe insulation protection saddle. Saddle size shall match adjacent piping insulation thickness.
Insulated cold piping	2-1/2” and larger	Model 403 carbon steel clevis hanger for insulated pipe with insulation protection shield spot welded in place. Install with 180° hard block calcium silicate insert with foil faced back (thickness to match adjacent pipe insulation). Insulation vapor barrier to be continuous at each hanger.

E. Support all pipe hangers from all-thread rod with additional lock nut. All-thread rod size shall match hanger attachment size. Attach all hangers to the structure with concrete inserts, "C" clamps with retainer straps, beam clamps, or ceiling flanges.

1. Hangers and supports anchored to poured concrete: Use malleable iron or steel concrete inserts attached to concrete forms.

2. Hangers or supports anchored to precast concrete: Use self-drilling expansion shields. Expansion shields may also be used where concrete inserts have been missed or additional support is required in poured concrete.

3. Attach all-thread rod 5/8" or smaller to steel with malleable iron beam clamps with carbon steel retainer strap.

4. Attach all-thread rod 3/4" or larger to steel with carbon steel center-load beam clamps with forged steel eye nut.

5. Attach all-thread rod to ceiling with malleable iron ceiling flanges, anchored to structural member above ceiling.

6. All adhesive hangers shall be approved for use with cracked concrete per the American Concrete Institute and ICC-ES standard AC308. All mechanical hangers shall be approved for use with cracked concrete per the American Concrete Institute and ICC-ES standard AC193.

F. Where piping is supported from below, support on carbon steel pipe saddle supports. Where piping is insulated, furnish with protection shields, insulation inserts and protection saddles similar to those used with pipe hangers. Support 2-1/2" or larger hot piping on roller supports.

G. In supporting cold piping systems, hanger installation shall permit the installation of a continuous insulation vapor barrier.

H. All insulated vertical or horizontal piping supported from walls shall have continuous insulation at all support clamps. At each support clamp provide a 360 degree thermoplastic elastomer cushion insert or calcium silicate shield insert; thickness shall match thickness of insulation. Provide continuous vapor barrier.

I. All non-insulated vertical or horizontal piping supported from walls shall have a 360 degree thermoplastic elastomer cushion insert at each support clamp.

2.3 VERTICAL PIPE FRICTION CLAMPS

A. In general support all vertical piping with friction type riser clamps - Model 450 or 451 for uninsulated pipes or Model 452 for insulated pipes.

1. Steel or cast iron piping – carbon steel.

2. Copper piping – copper plated carbon steel.

2.4 MANUFACTURED UNITS

A. Hangers and support components shall be factory fabricated of materials, design and manufacturer complying with MSS SP-58.

1. Components shall have galvanized coatings where installed for piping and equipment that will not have field-applied finish.

B. Thermal Hanger Shield Inserts: 100 psi average compressive strength, waterproofed calcium silicate, encased with a sheet metal shield. Insert and shield shall cover a 180 degree circumference of the pie and shall be of length indicated by manufacturer for pipe size and thickness of insulation.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide all hangers, supports and clamps to properly support and retain piping, to control expansion, contraction and drainage and to prevent sway and vibration.

B. Examine areas and conditions where the hangers, supports, clamps and inserts are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the installer. Proceed only after the required building structural work has been completed in the area where the piping is to be installed.

C. The use of explosive force hammer actuated, booster assist or similar anchoring device is not permitted without prior approval from the Engineer.

D. Provide all supplementary angles, channels, rails and plates required for support of piping. Attach to building structural members by welding, bolting or anchoring. Ceiling flanges shall be secured to the structural member above ceiling - anchoring ceiling flanges to drywall "only" is not acceptable.

E. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze hangers. Construct of a channel or unistrut with adjustable all-thread rods. Hanger spacing shall be determined by the smallest pipe supported. Provide all insulation protection shields, insulation inserts and protection saddles similar to those used with individual hangers. In supporting cold piping systems, trapeze hanger installation shall permit the installation of a continuous insulation vapor barrier.

F. Install hangers and supports to allow for controlled movement of the piping system, to permit movement between pipe anchors and to facilitate the action of expansion joints and bends.

G. Install hangers and supports to provide indicated pipe slopes.

H. Support all fire protection piping independently of other piping, per NFPA requirements.

I. Do not support piping from another pipe or from ductwork or equipment. Do not support ceiling framing or lighting from piping.

J. Adjust hangers and supports to equally distribute the load between all supporting members.

K. Support all vertical copper piping with riser clamps at intervals not over 10 feet. Support all vertical steel piping at intervals not over 15 feet.

L. Support all piping independently from equipment and isolate to prevent transmission of vibration of equipment to piping. No piping is to impose a load upon the equipment to which it is connected.

M. If any fire proofing materials are disturbed while attaching piping hangers and supports, patch/repair those areas with the same fire proofing materials and of the same thickness as adjacent areas.

END OF SECTION 23 12 20

SECTION 23 12 30
THERMOMETERS AND GAUGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Specifications of this Division complement the requirements of this Section.

1.2 SCOPE

A. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 SUMMARY

A. This Section specifies thermometers and gauges common to more than one section of Division 23 and includes materials, specialties, and basic installation instructions. Portions of this Section may not be required in this project. See drawings and each specific system description section of Division 23 for specific sizes; materials and installation methods pertaining to this project.

1.4 CODES AND STANDARDS

A. UL Compliance: Comply with applicable UL standards pertaining to thermometers and gauges.

B. ASME and ISA Compliance: Comply with applicable portions of ASME and Instrument Society of America (ISA) standards pertaining to construction and installation of thermometers and gauges.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide thermometers and pressure gauges as manufactured by one of the following:

1. Weiss Instruments, Inc.
2. Trerice Co.
3. Marshalltown Instruments, Inc.

2.2 THERMOMETERS - INTERIOR

A. Casing:

1. Die cast aluminum case and adjustable joint with baked enamel finish, 9" long, with spring secured heavy glass front and locking device capable of 180° vertical and 360° horizontal adjustment.

B. Instrument

1. Non-toxic safety liquid filled-magnifying lens, reading tube, silicone shock mounted.
2. Satin faced non-reflective aluminum scale with permanently etched markings.
3. Instrument shall be accurate to within 1% of scale range
4. Fill with red or blue liquid

C. Stem

1. Copper-plated steel stem, separable socket well, length to suit installation. Suitable for the service of the piping system where installed.

D. Pipe Wells

1. Wells shall be brass in copper pipe and stainless steel in steel pipe, pressure rated to match piping system design pressure. Where piping is to be insulated, provide with extension.

E. Scale

1. Provide temperature ranges as follows:

Table 23 12 30.1

Service	Range	Scale Graduations
Heating Water	30-240°F	2°F
Chilled Water	0-120°F	1°F
Glycol Chilled Water	0-120°F	1°F

2.3 PRESSURE GAUGES - INTERIOR

A. Conform to ANSI B40.1 grade 1A, with accuracy of plus or minus 1%.

B. Phosphor bronze bourdon-tube and brass socket for 1/4" NPT bottom connection.

C. 4-1/2" diameter steel case with clear acrylic plastic lense.

D. Aluminum dial with white background and permanently etched black markings.

E. Aluminum pointer with black finish.

F. Provide gauges with 1/4" NPT brass bushing snubbers with corrosion resistant porous metal disc suitable for the service and pressure rating of the piping system where installed. Between gauge and tee in piping system, provide 1/4" bronze body, threaded ball valve suitable for the service and pressure rating of the piping system where installed.

G. Where pressure gauge is installed in a steam system provide 1/4" NPT straight type brass steam gauge syphon.

H. Range: Conform to the following:

Table 23 12 30.2

Service	Range	Figure Interval	Minor Graduation
Heating Water	0-60 psig	5 psig	1.0 psig
Chilled Water	0-60 psig	5 psig	1.0 psig
Glycol Chilled Water	0-60 psig	5 psig	1.0 psig
Make-up Water	0-60 psig	5 psig	1.0 psig
Low Pressure Steam	0-15 psig	1 psig	0.2 psig
Medium Pressure Steam	0-100 psig	10 psig	1.0 psig
High Pressure Steam	0-160 psig	20 psig	2.0 psig

2.4 THERMOMETERS - EXTERIOR

A. Casing

1. Die cast aluminum case and adjustable joint with baked enamel finish, 9" long, with spring secured heavy glass front and locking device capable of 180° vertical and 360° horizontal adjustment.

B. Instrument

1. Non-toxic red safety liquid filled-magnifying lens, red reading tube, silicone shock mounted.

2. Satin faced non-reflective aluminum scale with permanently etched markings.

3. Fill with red or blue liquid

4. Instrument shall be accurate to within 1% of full scale

C. Stem

1. Copper-plated steel stem, separable socket well, length to suit installation. Suitable for the service of the piping system where installed.

D. Thermowell

1. Thermometer wells shall be brass in copper pipe and stainless steel in steel pipe, pressure rated to match piping system design pressure. Where piping is to be insulated, provide with extension.

E. Scale

1. Provide temperature ranges as follows:

Table 23 12 30.3

Service	Range	Scale Graduations	Minor Graduations
Glycol Chilled Water	-20-120°F	20°F	2°F

2.5 PRESSURE GAUGES - EXTERIOR

A. Conform to ANSI B40.1 grade A, with accuracy of plus or minus 0.5%.

B. Phosphor bronze C tube and brass socket for 1/4" NPT bottom connection.

C. 4-1/2" diameter steel case with clear acrylic plastic lense.

D. Aluminum dial with white background and permanently etched black markings.

E. Aluminum pointer with black finish.

F. Provide gauges with 1/4" NPT brass bushing snubbers with corrosion resistant porous metal disc suitable for the service and pressure rating of the piping system where installed. Between gauge and tee in piping system, provide 1/4" bronze body, threaded ball valve suitable for the service and pressure rating of the piping system where installed.

G. Gauge shall be rated for exterior use, and for the ambient temperature extremes it will be subjected to for the environment it is to be located in.

H. Range: Conform to the following:

Table 23 12 30.4

Service	Range	Figure Interval	Minor Graduation
Glycol Chilled Water	0-60 psig	5 psig	0.5 psig

PART 3 - EXECUTION

3.1 THERMOMETERS INSTALLATION

A. Install thermometers in vertical or tilted positions to allow reading by observer standing on the floor. Install thermometer wells in the vertical position. Fill well with oil or graphite and secure cap. Adjust faces to proper angle for best visibility.

B. Install thermometers in the following locations and elsewhere as indicated

1. At inlet and outlet of each air handling unit hydronic coil. Utilize interior thermometers.
2. At inlet and outlet of chiller (evaporator). Utilize exterior thermometers.
3. At inlet and outlet of boilers and heat exchangers.

3.2 PRESSURE GAUGES INSTALLATION

A. Install pressure gauges located in the piping at the most readable location for an observer standing on the floor. Install with shut off valve and snubber. For steam systems install with gauge siphon, Pressure gauges shall be installed as close as possible to the equipment or apparatus to indicate pressure changes across equipment or apparatus only. Adjust faces to proper angle for best visibility.

B. Install pressure gauges in the following locations and elsewhere as indicated.

1. At suction and discharge of each pump. Provide one pressure gauge with 2 independent ball valves piped to the suction and discharge piping of all pumps. Utilize interior pressure gauges
2. At inlet and outlet of each make-up water pressure reducing valve. Utilize interior pressure gauges.
3. At inlet and outlet of each chiller, both condenser and evaporator. Utilize exterior pressure gauges.
4. At inlet and outlet of each air handling unit hydronic coil. Utilize interior pressure gauges.
5. At outlet piping of each boiler (unless integral to the boiler).

3.3 ADJUSTING AND CLEANING

A. Adjusting: Adjust faces of thermometers and gauges to proper angle for best visibility.

B. Cleaning: Clean windows of thermometers and gauges and factory-finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touch-up paint.

C. Connections: Piping installation requirements are specified in other sections of Division 23. The drawings indicate the general arrangement of piping, fittings and specialties. The following are specific connection requirements:

1. Install thermometers and gauges piping adjacent to equipment to allow servicing and maintaining of equipment.

END OF SECTION 23 12 30

SECTION 23 12 40
FLEXIBLE PIPE CONNECTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies flexible pipe connectors common to more than one section of Division 23 and includes materials, specialties, and basic installation instructions.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

C. Portions of this Section may not be required in this project. See drawings and each specific system description section of Division 23 for specific sizes; materials and installation methods pertaining to this project.

1.3 QUALITY ASSURANCE

A. Provide flexible pipe connectors of same type by same manufacturer.

1.4 CODES AND STANDARDS

A. ASME Compliance: Manufacture and install flexible pipe connectors in accordance with ASME B31.9 "Building Services Piping."

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide flexible pipe connectors as manufactured by one of the following:

1. Hyspan Precision Products, Inc.
2. Keflex, Inc.
3. Hydronic Components, Inc. (a division of Jomar)
4. Mason Industries
5. Metraflex
6. Twin City Hose

2.2 WOVEN HOSE FLEXIBLE CONNECTORS

A. Stainless steel hose covered with stainless steel wire braid with MPT nipples rated at minimum 600 psig working at 250°F for pipe 2" and smaller; class flanges rated at 125 psig and 240°F maximum temperature for pipe 2½" and larger.

2.3 SPHERICAL RUBBER FLEXIBLE CONNECTORS

A. Neoprene or EPDM ("rubber") type flexible connector couplings constructed of multiple plies of nylon tire cord fabric, molded and cured in hydraulic rubber presses with galvanized steel aircraft cable flange connectors and 150 lb.

B. Class flanges rated at 125 psig and 240°F maximum temperature.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which flexible pipe connectors are to be installed.

B. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION

A. Install where indicated on the drawings and according to manufacturer's recommendations. Install in the following locations, even if not specifically indicated on the drawings:

1. Install spherical rubber flexible connectors at the chilled water piping connections to each chiller.

2. Install spherical rubber flexible connectors at the chilled water piping connections to each end suction water pump.

3. Install woven hose flexible connectors on the heating water piping connections to each boiler.

4. Install spherical rubber flexible connectors on the heating water piping connections to each heating water pump.

5. Install woven hose flexible connectors on the heating water piping connections to each inline water pump.

3.3 FIELD QUALITY CONTROL

A. Upon completion of installation of flexible pipe connectors and after units are water pressurized, test units to demonstrate capability and compliance with requirements.

B. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new unit sand proceed with retesting.

END OF SECTION 23 12 40

SECTION 23 13 10
HYDRONIC VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Specifications of this Division complement the requirements of this Section.

1.2 SUMMARY

A. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 DEFINITIONS

A. ANSI - American National Standards Institute.

B. ASME - American Society of Mechanical Engineers.

C. CWP - Cold Working Pressure.

D. EPDM - Ethylene Propylene Diene Monomer.

E. PSI - Pounds per square inch.

F. PSID - Pounds per square inch differential.

G. PSIG - Pounds per square inch gage.

H. P/T - Pressure and Temperature.

1.4 QUALITY ASSURANCE

A. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

2. ASME B31.9 for building services piping valves.

B. MSS Compliance:

1. MSS SP-67-90 Butterfly Valves

2. MSS SP-70-90 Cast Iron Gate Valves, Flanged or Threaded Ends

3. MSS SP-78-92 Cast Iron Plug Valves Flanged and Threaded

4. MSS SP-80-87 Bronze Gate, Globe, and Check Valves

5. MSS SP-85-85 Cast Iron Globe and Angle Valves, Flanged and Threaded Ends

6. MSS SP-110-92 Ball Valves Threaded, Socket-Welded, Solder Joint, Grooved and Flared Ends

C. All valves shall be installed in accordance with the Local Building Code.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

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

B. Use the following precautions during storage:

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

C. Use a sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL

A. Where possible provide all valves of the same manufacturer. All valves shall have the manufacturer's name (or trademark) and pressure rating clearly marked on the valve body.

B. Provide factory-fabricated valves of types and temperature/pressure ratings as indicated, suitable for the service in which the valve is installed.

C. Unless otherwise indicated, provide valves of same size as the pipe in which it is installed.

D. Where valves are to be insulated, provide an extended stem arranged to receive insulation.

E. Operators: Provide the following special operator features:

1. Lever handles, on quart-turn valves 6” and smaller, except for plug valves. Provide plug valves with square heads; provide one wrench for every 4 plug valves. (But no less than two wrenches total.)
2. Handwheels, fastened to valve stem, for valves other than quarter turn.
3. Chain-wheel operators, for valves 1-1/2 inch and larger, installed 72 inches or higher above finished floor elevation and called out on drawings. Extend chains to an elevation of 6”-0” above finished floor.
4. Gear drive operators, on quarter-turn valves 8” and larger.

2.2 SHUT-OFF BALL VALVES

A. 2" and smaller: Bronze body, two piece, full port ball valves with lever handle, Teflon seats, chrome plated brass ball, brass stem and threaded ends, 600 psi CWP. Note – manual air vents and drain valves shall be ½” ball valves with hose thread outlet.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide shut-off valves as manufactured by one of the following:

1. Apollo
2. Hammond
3. Hydronic Components, Inc. (a division of Jomar)
4. Jomar Valve

5. Milwaukee
6. Nibco
7. Stockham
8. Watts

2.3 SHUT-OFF BUTTERFLY VALVES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide shut-off valves as manufactured by one of the following:

1. Apollo
2. Hammond
3. Hydronic Components, Inc. (a division of Jomar)
4. Metraflex
5. Milwaukee
6. Nexus
7. Nibco
8. Stockham

2.4 SILENT CHECK VALVES

A. All sizes: Globe style, silent check valve with cast iron body, bronze seat and plug and stainless steel spring, 125 psi working pressure, with threaded ends for sizes 2-1/2" and smaller, with flanged ends for sizes 3" and larger.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide silent check valves as manufactured by one of the following:

1. Crane
2. Mueller
3. Muessco
4. Nibco
5. Williams-Hager

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION

A. Shut-off valves shall be provided at all branch connections to piping mains, at bases of all risers, at each piece of equipment, in piping mains to sectionalize the systems and elsewhere as indicated. Valve locations shall permit proper and safe operation of all systems and facilitate maintenance and/or removal of all equipment and apparatus.

B. All valves shall be installed in accessible locations in a position to allow full stem movement. On horizontal overhead runs, install valves with stems in the horizontal position. On horizontal runs near the floor, install valves with stem in the vertical or 45 degree angle position.

C. In no case shall valves be installed with stems below the horizontal position.

D. Provide 3/4" drain valves with hose thread fitting and cap with chain at all piping low points, trapped sections, bases of risers, and on equipment side of shut-off valves to permit draining.

E. Valves shall be installed full line size. Piping reductions shall be made only at the inlet or outlet of control valves, pressure reducing valves, regulating valves, or equipment.

F. Install silent check valves in the vertical position with stem upright and plumb. Install for proper direction of flow at discharge of pumps.

3.3 VALVE TYPE

A. Furnish valves of the appropriate type as indicated in Table 23 13 10.1.

Table 23 13 10.1

Pipe Size	Valve Type
2” and smaller	Ball
2-1/2” and larger	Butterfly

3.4 ADJUSTING

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

END OF SECTION 23 13 10

SECTION 23 13 40
REFRIGERANT VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies refrigeration system valves, and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. All refrigeration systems shall be installed in accordance with the Local Mechanical Code and the Safety Code for Mechanical Refrigeration (ANSI B9.1).

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 SHUT-OFF VALVES

A. Angle pattern or straight through design, cast bronze body with cast bronze or forged brass wing cap and bolted bonnet, replaceable resilient seat disc, plated steel stem, solder ends, capable of being repacked under pressure, 450 psig working pressure, 275 °F operating temperature.

2.2 SOLENOID VALVES

A. Two-way straight through design, forged brass, Teflon valve seat, solder ends, 400 psig working pressure, 250 °F operating temperature. Furnish complete with NEMA 1 solenoid enclosure with ½ inch conduit adapter, 24 volt, 60 Hz normally closed holding coil and manual operator to open valve.

2.3 THERMOSTATIC EXPANSION VALVES

A. Thermostatic adjustable modulating type, complete with sensing bulb, distributor with side connection for hot gas bypass line and external equalizer line, solder ends. Size as required for specific requirements and factory set for proper evaporator superheat requirements.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide necessary valves as indicated on the drawings or as recommend by the equipment manufacturer's installation instructions for each separate refrigerant circuit for multiple compressor applications.

B. All refrigerant valves shall be integrated into the piping system with brazed joints. Continuously purge joints while being brazed with oil-free dry nitrogen to prevent the formation of scale within the tubing.

C. Refrigerant valves sizing and position within the piping system shall be approved by the equipment manufacturer.

3.2 TESTING AND CHARGING

A. Test refrigerant piping with oil-free pumped dry nitrogen. Twenty four hour standing time minimum. Test low side of the system to 150 psi and high side to 300 psi. Tests shall conform to "Pressure Piping Code" 4101:8-3 and ANSI Standard B31.5 "Refrigerant Piping". Leak test piping and joints with an electronic or halide leak detector.

B. Evacuate entire system with an approved high vacuum pump system to 500 microns. Evacuate and charge system with refrigerant as required to place equipment in operation. Provide full operating charge.

END OF SECTION 23 13 40

SECTION 23 14 10
HYDRONIC MANUAL BALANCE VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SUMMARY

A. This Section specifies valves used in hydronic piping systems and includes general descriptions and installation methods.

1.3 DEFINITIONS

A. ANSI - American National Standards Institute.

B. ASME - American Society of Mechanical Engineers.

C. CWP - Cold Working Pressure.

D. EPDM - Ethylene Propylene Diene Monomer.

E. PSI - Pounds per square inch.

F. PSID - Pounds per square inch differential.

G. PSIG - Pounds per square inch gage.

H. P/T - Pressure and Temperature.

1.4 QUALITY ASSURANCE

A. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

2. ASME B31.9 for building services piping valves.

B. All valves shall be installed in accordance with the Local Building Code.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.

2. Protect threads, flange faces, grooves, and weld ends.

3. Set valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.

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

C. Use a sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

1.6 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 GENERAL VALVE REQUIREMENTS

A. Where possible provide all valves of the same manufacturer. All valves shall have the manufacturer's name (or trademark) and pressure rating clearly marked on the valve body.

B. Provide factory-fabricated valves of types and temperature/pressure ratings as indicated, suitable for the service in which the valve is installed.

C. Unless otherwise indicated, provide valves of same size as the pipe in which it is installed.

D. Where valves are to be insulated, provide an extended stem arranged to receive insulation.

2.2 MANUAL BALANCING VALVES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide manual balancing valves as manufactured by one of the following:

1. Flow Design Inc.
2. Griswold
3. Hydronic Components, Inc. (a division of Jomar)
4. Nexus
5. Red White Valve Corp.

B. 2" and smaller:

1. Valves shall be combination venturi and ball valve with brass body, lever handle, memory stop, two P/T ports, inlet union connection and threaded ends, 400 psi at 250°F.

C. 2-1/2" and larger:

1. Valves shall be butterfly throttling valve with separate venturi flow meter. Assembly shall be rated for 240 psi at 250 degrees F and shall have an accuracy of +/-3%.
2. Butterfly Valve shall have cast iron lug-type body meeting ANSI class 125/150, with EPDM gasket and seat, 416 stainless steel stem, bronze sleeve bearing and aluminum or bronze disc.
3. Venturi flow meter shall be constructed of Steel body, meeting ASTM A120, with low loss piezo-ring throat. Venturi shall have differential readout ports consisting of extended superseal pressure and temperature test ports. Provide venturi's with flanged connections, rated at 125 psig working pressure and constructed of cast iron. Venturis shall have a precision machined throat with an accuracy of 3%. Permanent pressure drop through the venturi's shall not exceed 2 feet at design flow.

2.3 THROTTLING VALVES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide throttling valves as manufactured by one of the following:

1. Dezurik
2. Key Port
3. Val-Matic

B. Throttling valves 2-1/2" and larger shall be plug valves constructed of cast iron body, stainless steel trim, resilient faced plug with flanged ends and memory stop, 150 psi working pressure. Provide square head operators for sizes 2-1/2" to 4"; gear operators for sizes 6" and larger.

C. Provide one wrench for every four valves with a minimum of two wrenches. Wrenches shall be locked in place with a set screw.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION

A. All valves shall be installed in accessible locations in a position to allow full stem movement. On horizontal overhead runs, install valves with stems in the horizontal position. On horizontal runs near the floor, install valves with stem in the vertical or 45 degree angle position.

B. In no case shall valves be installed with stems below the horizontal position.

C. Install all piping with reduction in size being made only at the inlet and outlet of control valves, regulating valves and equipment. All hydronic manual balance valves shall be installed full line size.

D. Install balancing valves with at least the minimum straight length of pipe, upstream and downstream of the valve, required by the manufacturer for maximum accuracy.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing.

B. Replace valves if persistent leaking occurs.

3.4 APPLICATION

A. Manual balancing valves (2" & smaller): All terminal units, where indicated on drawings

B. Manual balancing valves (2-1/2" & larger): Air handling unit coils

C. Flow throttling valves: Pump Discharges

END OF SECTION 23 14 10

SECTION 23 14 20
HYDRONIC AUTOMATIC BALANCE VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies automatic balance valves used in hydronic piping systems and includes general descriptions and installation methods. See Drawings for specific sizes and installation requirements.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 DEFINITIONS

A. ANSI - American National Standards Institute.

B. ASME - American Society of Mechanical Engineers.

C. CWP - Cold Working Pressure.

D. EPDM - Ethylene Propylene Diene Monomer.

E. PSI - Pounds per square inch.

F. PSID - Pounds per square inch differential.

G. PSIG - Pounds per square inch gage.

H. P/T - Pressure and Temperature.

1.4 QUALITY ASSURANCE

A. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

2. ASME B31.9 for building services piping valves.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.

2. Protect threads, flange faces, grooves, and weld ends.

3. Set valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.

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

1.6 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Subject to compliance with requirements, provide automatic balancing valves as manufactured by one of the following:

1. Flow Design, Inc.
2. Griswold
3. Hydronic Components, Inc. (a division of Jomar)
4. Nexus Valve, Inc.
5. Red White Valve Corp.

2.2 GENERAL

A. Where possible provide all valves of the same manufacturer. All valves shall have the manufacturer's name (or trademark) and pressure rating clearly marked on the valve body.

B. Provide factory-fabricated valves of types and temperature/pressure ratings as indicated, suitable for the service in which the valve is installed.

C. Unless otherwise indicated, provide valves of same size as the pipe in which it is installed.

D. Where valves are to be insulated, provide extended ports arranged to receive insulation.

2.3 AUTOMATIC BALANCING VALVES

A. Provide factory calibrated, direct acting, automatic pressure compensating type automatic balancing valves. The GPM for the automatic flow control valves shall be factory set and shall automatically limit the rate of flow to within 5% of the specified GPM over at least 95 percent of the control range.

B. Each flow cartridge shall be self-cleaning, constructed with stainless steel moving parts and be accessible without the use of special tools. The flow cartridge's non-clogging orifice design shall include no metal-to-metal contact, no segmented ports, and incorporate a flow nozzle and metering disk controlled by a pressure compensating spring.

C. The flow cartridge shall be factory flow tested and calibrated to maintain accuracy of ±5%; the accuracy shall be maintained over an operating range of 2 – 32 PSID.

D. Manufacturer shall provide cartridge exchange for up to one (1) year from date of delivery at no charge. Exchange shall be provided for flow rate changes within same valve body.

E. Flow cartridges shall carry a 5 year material warranty.

F. Valves 2" and smaller shall have brass Y-pattern body with integral ball valve, (2) pressure/temperature test ports, a tag indicating the model, flow rate and PSID range, blowout proof stem with dual Viton o-ring seals, interchangeable union end with Viton o-ring seal, hard chrome plated full-port ball with Teflon seats, and rated at 600 PSI WOG, 325 degrees F. Valves shall have threaded connections. The flow cartridge shall be removable from the Y-body housing without the use of special tools to provide access for regulator change-out, inspection and cleaning without breaking the main piping.

G. Valves 2½" and larger shall be a wafer style ductile iron or cast iron body with pressure and temperature test plugs across the flow cartridges; a tag indicating the model, flow rate and operating control range; with a drain and rated at 150 PSI, 275° F.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent cartridge movement during shipping and handling.

B. Examine threads on valve and mating pipe for form and cleanliness.

C. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

D. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION

A. All valves shall be installed in accessible locations.

B. Install valves with at least the minimum straight length of pipe, upstream and downstream of the valve, required by the manufacturer for maximum accuracy.

C. Install all piping with reduction in size being made only at the inlet and outlet of control valves, regulating valves and equipment. All hydronic automatic balance valves shall be installed full line size.

END OF SECTION 23 14 20

SECTION 23 14 30
HYDRONIC COIL PIPING PACKAGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SUMMARY

A. This Section specifies valves used in hydronic piping systems and includes general descriptions and installation methods.

1.3 DEFINITIONS

A. ANSI - American National Standards Institute.

B. ASME - American Society of Mechanical Engineers.

C. CWP - Cold Working Pressure.

D. EPDM - Ethylene Propylene Diene Monomer.

E. PSI - Pounds per square inch.

F. PSID - Pounds per square inch differential.

G. PSIG - Pounds per square inch gage.

H. P/T - Pressure and Temperature.

1.4 QUALITY ASSURANCE

A. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

2. ASME B31.9 for building services piping valves.

B. All valves shall be installed in accordance with the Local Building Code.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.

2. Protect threads, flange faces, grooves, and weld ends.

3. Set valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.

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

1.6 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Subject to compliance with requirements, provide shut-off valves as manufactured by one of the following:

1. Nexus Valve, Inc.
2. Griswold
3. Flow Design, Inc.
4. Hydronic Components, Inc. (a division of Jomar)
1. Red White Valve Corp.

2.2 GENERAL

A. Where possible provide all valves of the same manufacturer. All valves shall have the manufacturer's name (or trademark) and pressure rating clearly marked on the valve body.

B. Provide factory-fabricated valves of types and temperature/pressure ratings as indicated, suitable for the service in which the valve is installed.

C. Unless otherwise indicated, provide valves of same size as the pipe in which it is installed.

D. Where valves are to be insulated, provide an extended stem arranged to receive insulation.

E. Coil Packages shall be designed for a minimum 600 PSIG working pressure for sizes ½" through 1½", 400 PSIG for 2"; and up to 325°F.

F. Each Coil Package is to include a combination automatic flow control valve, isolation valve and union with (2) pressure & temperature test plugs; combination y-strainer, isolation valve and union with blow down drain valve and (1) pressure and temperature test plug; accessory port union with (1) manual air vent and (1) pressure and temperature test plug.

G. Furnish extended pressure and temperature test plugs, manual air vents and valve handles. Extended valve handles shall not break the vapor barrier when operated.

2.3 AUTOMATIC FLOW CONTROL VALVES

A. The flow cartridge's non-clogging service design shall include no metal-to-metal contact, no segmented ports, and incorporate a flow nozzle and metering disk controlled by a pressure compensating spring.

B. The flow cartridge shall be a single assembly, constructed with stainless steel moving parts and be accessible without removing the valve from the piping.

C. The flow cartridge shall be factory flow tested and calibrated to maintain accuracy of ±5%; the accuracy shall be maintained over an operating range of 2 – 45 PSID.

D. The flow cartridge shall carry a 5 year material warranty.

E. Valves 1-½" and smaller shall be a forged brass Y-pattern body and valves 2" shall be a cast brass y-pattern body with full port ball valve, (2) pressure/temperature test ports, a tag indicating the model, flow rate and PSID range, blowout proof stem with dual Viton/EPDM o-ring seals, interchangeable union end with Viton/EPDM o-ring seal, hard chrome plated ball with Teflon seats, and rated at 600 PSI WOG, 325 degrees F; like Nexus UM.

2.4 Y STRAINERS

A. Y type strainers ½" through 2" shall be a combination Y Strainer and Ball Valve with integrated Union. Valves shall be a forged brass construction for sizes ½" through 1-½" and cast brass for 2" with the following features:

B. A minimum of 600 PSI WOG, 325°F.

C. Interchangable union end with Viton o-ring seal.

D. Multiple ¼" tapped ports for test plugs, vents or other accessories.

E. Blowout proof stem with dual Viton o-rings.

F. Hard chrome plated ball with Teflon seats.

G. A 304 stainless steel filter screen accessible without affecting the valve piping.

H. A port in the filter cap for a blowdown/drain valve; like Nexus UY.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. All valves shall be installed in accessible locations in a position to allow full stem movement. On horizontal overhead runs, install valves with stems in the horizontal position. On horizontal runs near the floor, install valves with stem in the vertical or 45 degree angle position.

B. In no case shall valves be installed with stems below the horizontal position.

C. Valves shall be installed full line size. Piping reductions shall be made only at the inlet or outlet of control valves, pressure reducing valves, regulating valves, or equipment.

D. Install balancing valves with at least the minimum straight length of pipe, upstream and downstream of the valve, required by the manufacturer for maximum accuracy.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing.

B. Replace valves if persistent leaking occurs.

END OF SECTION 23 14 30

SECTION 23 15 10
FLOW MEASURING DEVICE - VENTURI

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies Venturi flow meters and includes materials, accessories, and basic installation instructions. See drawings and each specific system description section of Division 23 for specific sizes; materials and installation methods pertaining to this project.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. ASME Compliance: Manufacture and install Venturi meters in accordance with ASME B31.9 "Building Services Piping."

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Provide flow measuring venture meters as manufactured by one of the following:

1. Bell + Gossett
2. Flow Design Inc.
3. Griswold
4. Nexus
5. Taco, Inc.

2.2 VENTURIS

A. Provide flow measuring venturis, where indicated on the drawings. Venturis shall have a precision machined throat with an accuracy of 3%. Venturi shall have differential readabout ports. Permanent pressure drop through the venture shall not exceed 2 feet at design flow.

B. Venturis 2” and smaller shall have threaded connections, rated at 125 psig working pressure and be constructed of bronze or brass. Venturis 2-1/2” and larger shall have flanged connections, rated at 125 psig working pressure and be constructed of cast iron.

C. Venturi shall have differential readout ports fitted with check valve and protective cap.

D. Where indicated, provide venturi with a throttling valve with a memory stop on the downstream side of the venture. Provide full port ball valves (sizes ½" – 2") with brass or bronze body, blowout-proof stem, virgin Teflon seats, brass stem and packing nut and a steel handle.

E. All butterfly valves 2" tom 14", shall be cast iron full-lug type, with EPDM seat, 416 s.s. stem, bronze sleeve bearing and an alum./bronze disk.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which flow measuring Venturis are to be installed.

B. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION

A. Install venturis in accessible locations according to manufacturer's recommendations. Maintain manufacturer's required minimum lengths of straight pipe both upstream and downstream.

3.3 FIELD QUALITY CONTROL

A. Upon completion of installation of flow measuring venturi's, and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new unit and proceed with retesting.

END OF SECTION 23 15 10

SECTION 23 16 10
CLOSED LOOP WATER TREATMENT SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies chemical treatment for closed loop water systems and includes necessary chemicals and equipment for cleaning and flushing of systems to inhibit development of scale, corrosion, and biological growth.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

C. Provide water treatment and chemicals for the following systems:

1. Heating hot water system

1.3 QUALITY ASSURANCE

A. Equipment Manufacturer Qualifications:

1. Shall be able to document a minimum of **10 YEARS** experience designing, manufacturing and supplying products for commercial and industrial water treatment and water chemistry control.

2. Shall maintain engineering and field service capabilities to ensure proper operation of product within the service period specified in subsequent sections.

3. Shall be able to document the treatment program for the first year of operations including:

a. Assurance of manufacturer examination service reports.

b. Program for noting and communicating deviations reported.

c. Lines of responsibility for corrective actions to cure deviations.

4. Shall be registered with the US EPA registration as pesticide, device or active ingredient producing establishment.

B. Chemical Supplier and Water Treatment Service Company Qualifications:

1. Facilities:

a. Shall have their own laboratory for analysis of water samples, deposit analysis and metallurgical analysis and technical assistance.

2. Scope of Service:

a. Shall schedule service in order to evaluate monitoring tools, testing protocol, control limits, and to provide electronic reports or acceptable alternative for each visit.

b. Shall be able to respond on emergency basis within 2 hours by phone and within 24 hours on site.

c. Shall perform on site inspections of equipment with three days notice by customer providing report on findings.

3. Shall provide start-up assistance and commissioning assistance as required without additional cost to the owner.

4. Shall have a minimum of ten years experience in the water treatment business, have laboratory facilities and staff capable of performing all necessary analyses relating to the performance of water treatment program.

5. Shall furnish products ready to use.

6. Shall be registered with the US EPA registration as pesticide, device or active ingredient producing establishment.

1.4 CODES AND STANDARDS

A. UL and NEMA Compliance: Provide electrical components required as part of water treatment equipment, which are UL listed and labeled, and comply with NEMA Standards.

B. NEC Compliance: Comply with NEC as applicable to installation and electrical connections of ancillary electrical components of water treatment equipment.

C. Chemical Standards: Provide only chemical products which are acceptable under state and local pollution control regulations.

1.5 REFERENCES

A. ABMA - American Boiler Manufacturing Association.

B. ASME Boiler and Pressure Vessel Code - Section VIII; Ruler for the Construction of Pressure Vessels Division 1.

C. ASTM G4-01(2008) Standard for Conducting Corrosion Coupon Tests in Field Applications.

D. CTI Code STD-149(00) Corrosion Testing Procedures, Corrosion Coupon Testing and Test Devices.

E. OSH Regulations Standards – 29CFR, PART 1900, Standard 1200, Toxic and Hazardous Substances (MSDS).

F. SMEWW (2004) – Standard Methods for the Examination of Waste Water.

G. US Federal Communications Commission CFR 47(FCC) PART 18, 2006 for radiated emissions.

H. US Environmental Protection Agency (EPA) FIFRA compliance as per 7 U.S.C. SS 136e and US EPA compliance as per 40CFR PART 167.

I. US EPA – EPP – Environmentally Preferred Purchases including in Executive Order 13423 – Strengthening Federal Environmental, Energy, and Transportation Management.

1.6 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

C. Start-up Report:

1. Special

2. MSDS Sheets: Submit copies of MSDS sheets for all chemicals utilized in the water treatment process

3. Raw Water Analysis: Submit a copy of the project site water analysis to document the water quality available at the project site.

1.7 WATER ANALYSIS

A. Prior to the final determination of the requirements of the water treatment program, an analysis shall be made of all waters to be treated. This includes the testing of any systems that are to be expanded, or supply water to any new system.

B. Testing shall be performed in a recognized laboratory under the direction of the water treatment Contractor.

C. Raw water test analysis shall include at a minimum the analysis of the following compositions of the water:

1. Calcium Hardness (as ppm CaCO3)
2. Total Hardness (as ppm CaCO3)
3. Total Alkalinity or m-Alkalinity (as ppm CaCO3)
4. Ph
5. Silica (as SiO2)
6. Specific Conductivity (µS/cm)
7. Sulfate (as SO4)
8. Chloride (as Cl-)
9. Phosphate (as PO4)

1.8 EXTENDED MAINTENANCE SERVICES

A. Agreement to Maintain: Prior to time of final acceptance, submit 4 copies of "Agreement for Continued Service and Maintenance" for water treatment system, for Owner's possible acceptance. Offer terms and conditions for furnishing chemicals and providing continued testing and servicing, and including replacement of materials and equipment, for one-year period with option for yearly renewal of Agreement by Owner.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products and service by one of the following manufacturers and their authorized representative:

1. GLA Water Treatment – Contact Paul Kobus, cell: (440) 343-1824
2. Chem Treat Inc. – Contact Joe Royle, cell: (216) 401-1843
3. ChemAqua – Contact Bill Messick, cell: (216) 870-6798
4. Aquascience.
5. Calgon
6. Dolphin WaterCare: A Division of Clearwater Systems Corporation.
7. DuBois Chemicals, Inc.; Div. of Diversey Corporation.
8. GE Infrastructure.
9. Patriot Industrial Technologies LTD
10. Watcon, Inc.

2.2 BY-PASS (POT) FEEDERS

A. Approved manufacturer: Subject to compliance with requirements, provide products as manufactured by one of the following:

1. Aqua Science
2. Griswold Water Systems
3. H-O-H Water Technology, Inc.
4. Neptune type BDF, FTF, or approved equal.
5. Sumco Technologies, Ltd.
6. Vector Industries, Inc.

B. Provide bypass feeders with a capacity of **5** gallons. The feeder shell shall be constructed of 11 gauge steel minimum for 2 gallon units and 10 gauge steel minimum for 5 gallon and larger units. Tank heads shall be a minimum of 11 gauge steel for 2 gallon units and a minimum 9 gauge steel for 5 gallon units. The bypass feeder shall be rated at 300 psi and to 200°F.

C. The tank shall have a wide mouth, minimum 3-1/2" opening so that chemical addition can be performed without the need of a funnel. The bypass feeder shall have a continuous threaded closure requiring 2-1/2 turns to close and seal. Closures using partial threads or lugs shall not be considered.

D. The cap shall be constructed of cast iron with an epoxy-coated underside to prevent corrosion and shall use a square ring gasket seal. The ring gasket shall bot be glued or restrained from movement. Closures using "o" rings or gaskets which are glued or restrained from free movement by snap rings shall not be considered equal.

E. Options:

1. Legs – The bypass feeder shall be provided with legs to elevate the feeder off the floor. The legs shall have holes to allow mounting by anchor bolts.
2. Filter –
    a. Bag Filter – The bypass feeder shall be provided with a **20** micron filter bag fully supported by a stainless steel filter basket for simultaneous side stream filtering.

F. Furnish five (5) additional 20 micron filter bags. Obtain receipt from Owner.

2.3 CLOSED CIRCUIT WATER TREATMENT

A. Cleaning Chemical: This material shall be a blend of organic dispersant, polymers, caustic conditioners and corrosion inhibitors, with a 1% solution having a pH of 10. Chemical shall be injected at the rate of 1.5 gallons/1000 gallons of water maintaining 400 PPM hydroxide alkalinity. During cleaning, the iron reading shall not exceed 20 PPM and TDS shall not exceed 3000 M/M. If either level is exceeded, discharge solution and add fresh water and cleaning solution until above limits are maintained.

B. Water treatment for closed water loops systems shall, after cleaning and flushing, add a nitrite/molybdate or equivalent chemical product which is designed specifically for the system metallurgy and water conditions, such as DuBois Isogard, Omnigard or equivalent.

1. Nitrite level in closed water loops treated primarily with nitrite components shall be maintained between 750 and 1,200 on butrute at all times unless otherwise indicated by corrosion coupon data.
2. pH control shall be maintained by product selection as recommended by the chemical water treatment system Contractor.

C. In loops treated with products of molybdenum and synergistic components, molybdenum level should be maintained at 12-15 ppm unless otherwise indicated by corrosion coupon data or supplier recommendations.

2.4 WATER SERVICE PROGRAM

A. The chemical treatment system supplier shall provide chemical and consulting services for 1 year from date of acceptance of system by the Owner. Minimum service requirements shall include:

1. Quarterly sample and testing.
2. Additional chemicals if needed for closed loop systems.
3. Bypass feeder filter change.
4. Testing of: PH, alkalinity, conductance, inhibitor, microbiological dip slide, and % glycol.
5. Visual check of system.
6. Written report documenting all of the items above.

B. Service program shall include technical assistance to the Contractor during installation, supervision of chemical cleaning, and instructions of Owner's personnel in the operation, monitoring, and control of each chemical treatment system.

C. The chemical treatment system supplier shall maintain a continuing program of service and supervision, including a service call every 3 months during the first year after system start-up.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Examine areas and conditions under which water treatment systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to the Installer.

3.2 INSTALLATION OF WATER TREATMENT SYSTEM

A. General: Install water treatment system in accordance with manufacturer's written instructions.

B. The filter feeder shall be piped across the circulating pump, or as otherwise indicated or required to insure positive flow through the tank. It shall be piped so that direction of flow is in the bottom and out the top. All piping to and from the feeder shall be schedule 80 black steel.

C. The feeder shall be firmly mounted to a wall, column, etc. or placed on a floor stand, and not supported by the supply and return piping.

D. The filler opening shall be not more than 48 inches above the floor for ease of use and to avoid any splashing of chemicals on the operator.

E. Coordinate work with plumbing and piping work as necessary to interface components of the water treatment system properly with the piping system. Route drain lines to appropriate drain inlet.

F. Mount pressure gages, valves, and controls furnished by manufacturer, in accordance with manufacturer's instructions.

3.3 CLEANING AND FLUSHING

A. Water used for hydrostatic testing shall be drained from the system to be cleaned.

B. Prior to placing the water system in operation, the entire water system shall be cleaned and flushed in accordance with the manufacturers written recommendations, using DuBois Met-All Terj or Liquid 422 or equivalent.

C. Following the precleaning procedures, pre-filming procedures shall be implemented according to the specifications using DuBois Passivate Plus PBB or equivalent product, following guidelines per package instructions.

3.4 CLOSED CIRCUIT WATER TREATMENT SYSTEMS

A. General: Provide a chemical treatment system to control corrosion in each closed water system. All necessary cleaning and corrosion inhibitor chemicals, feed equipment, test equipment, service, and monitoring shall be furnished by the chemical treatment system supplier and installed by the Contractor.

B. Cleaning and Filling Procedure:

1. Each closed water system shall be filled and flushed with clean water.

2. The system shall then be refilled with clean water to which appropriate cleaning chemicals have been added to remove pipe dope, fabrication lubricants, oils, welding slag, loose mill scale, and other extraneous materials. The system shall then be circulated for at least 48 hours, drained, and flushed with clean water.

3. After the cleaning chemicals have been thoroughly flushed from the system, the system shall be refilled with clean water to which the appropriate scale and deposit inhibitors, corrosion inhibitors, and microbiological control agents have been added.

3.5 DELIVERY, STORAGE, AND HANDLING

A. Equipment and Accessories:

1. Comply with manufacturer's instructions. Store in original packaging.

2. Store in a dry location, protected from the elements, and from mud, dirt and soiling.

3. Protect components from damage during storage and handling.

4. Handle with care to prevent damage during movement and installation.

B. Chemical Products and Supplies

1. Store in original packaging with intact factory labeling in a dry location, protected from the elements, and from mud, dirt and soiling.

2. Observe label instructions for handling and storage conditions.

3. Provide liquid containment protection.

4. Provide to the construction supervisor or owners representative all MSDS information for products on the site.

3.6 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.7 START-UP

A. Start-up Procedures: During system startup, operate each water treatment system (after charging with specified chemicals) to maintain required steady-state characteristics.

3.8 SERVICE PROGRAM

A. The chemical treatment system supplier shall provide a service program which shall include technical assistance to the Contractor during installation, supervision of chemical cleaning, and instructions of Owner's personnel in the operation, monitoring, and control of each chemical treatment system.

B. The chemical treatment system supplier shall maintain a continuing program of service and supervision, including a service call each month during the first year after system start-up.

3.9 FIELD QUALITY CONTROL

A. Engage a water treatment service representative to perform startup of service.

1. Inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

2. Clean system as previously describe.

3. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational.

4. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.

3.10 ADJUSTING

A. First Year Monitoring Service

1. Every 90 days from Initial Start-up Service, a water treatment representative shall monitor the performance of the system.

2. A written Service Report shall be provided to the owner/operator. The monitoring report shall include the following:

a. Inspection of the System for functionality.

b. Inspection of filtration, automation and equipment for operation and condition.

c. Visual inspection of overall system condition as accessible. Service visits may be timed to coincide with the opening of certain system components such as a closed vessel or chiller.

d. At each service visits, a field analysis of the following water chemistry parameters shall be performed using field test kits.

1). Total Bacteria Count, planktonic (by prepackaged dipslide)

2). pH

3). Specific Conductivity(μS/cm)

4). Chloride(as Cl-)

5). Total Hardness (as ppm CaCO3)

6). Total Alkalinity or m-Alkalinity (as ppm CaCO3)

7). Calcium Hardness (as ppm CaCO3)

3.11 TRAINING OF OWNER'S PERSONNEL

A. Provide services of supplier's technical representative for two (2) separate-four hour days to instruct Owner's personnel in operation, maintenance, and testing procedures of each water treatment system.

END OF SECTION 23 16 10

SECTION 23 17 10
AIR SEPARATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies air separators common to more than one section of Division 23 and includes materials, specialties, and basic installation instructions.

B. See drawings and each specific system description section of Division 23 for specific sizes; materials and installation methods pertaining to this project.

C. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air separators, of types and capacities required, whose products have been in satisfactory use in similar service for not less than three (3) years.

B. Provide air separators of same type by same manufacturer.

1.4 CODES AND STANDARDS

A. ASME Compliance: Manufacture and install air separators in accordance with ASME B31.9 "Building Services Piping."

B. UL and NEMA Compliance: Provide electrical components of HVAC specialties which are listed and labeled by UL, and comply with NEMA standards.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept equipment on site in shipping containers with labeling in place. Immediately inspect for damage.

B. Protect piping components from entry of foreign materials by providing temporary end caps and closures on piping and fittings. Maintain end caps in place until installation.

1.6 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 20.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide air separator as manufactured by one of the following:

1. Bell & Gossett ITT; Fluid Handling Div.

2. Spirotherm, Inc.
3. Taco, Inc.
4. Thrush Co., Inc.

2.2 GENERAL

A. Provide line-size air separators with flanged inlet and outlet connections.

B. Unit shall have separate top fittings for connection to system expansion tank and for automatic air vent. The unit shall have a bottom connection for blowdown cleaning. Unit must be constructed in accordance with the ASME boiler and pressure vessel code and stamped 125 psig design pressure.

C. Air separation and removal device shall be constructed of steel. It shall be designed, fabricated and stamped per ASME Section VIII Division 1 with a maximum working pressure of 125 psi at 270°F.

D. Air and dirt separation and removal device shall be constructed of steel. It shall be designed, fabricated and stamped per ASME Section VIII Division 1 with a maximum working pressure of 125 psi at 270°F.

E. The air and dirt removal device shall remove air down to 18 microns and shall remove dirt/debris down to 35 microns. The unit shall be 100% efficient at removing dirt down to 90 microns in 100 passes or less.

F. The air and dirt separator shall employ the use of high surface area pall rings to achieve optimal separation of air and dirt with minimal pressure drop. The pall ring shall be made of stainless steel. Stainless steel will be the only acceptable material used for suppressing turbulence and increasing surface area for high efficiency air and dirt removal. Inferior materials of construction such as copper for the straining medium will not be acceptable.

G. Each air and dirt removal device shall be equipped with a brass conical shaped air venting chamber designed to minimize system fluid from fouling the venting assembly. The air vent shall be able to be closed to allow flushing and purging of dirt via side port without dirt passing through vent on initial system fill.

H. The unit manufacturer shall provide the Owner and Design Engineer third party independent test data certifying that their unit performs to the above standards. Suppliers not providing these independent performance test results will not be acceptable.

2.3 ACCESSORIES

A. A brass flushing cock shall be located on the side of each separator to facilitate system fast-fill and removal of the floating impurities from the air system interface within the separator.

B. A blow down valve shall be provided by the unit manufacturer on the bottom of each unit to allow blow down and cleaning. On units 2 1/2" and smaller the valve and all of its fittings shall be 1". On units three 3" and larger the valve and all openings shall be 2".

2.4 AUTOMATIC AIR VENTS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide vent valves of one of the following:

1. Armstrong Machine Works
2. Bell & Gossett ITT; Fluid Handing Div.
3. Hoffman Specialty ITT: Fluid Handling Div.

B. Provide automatic air vents designed to vent automatically with float principle, stainless steel float and mechanisms, cast-iron body, pressure rated for 125 psi, 1/2" NPS inlet and outlet connections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which air separators are to be installed.

B. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION

A. Air Separator: Install air separator at high point of heating water supply piping. Connect inlet and outlet piping. Run 3/4 inch piping to expansion tank. Install one (1) inch ball type blowdown valve and cap. Install automatic air vent at top of air separator with shutoff valve.

B. Automatic Air Vents: Install automatic air vents at tops of air separator and elsewhere as indicated. Install shutoff valve between riser and vent valve.

3.3 FIELD QUALITY CONTROL

A. Upon completion of installation of air separators and after units are water pressurized, test units to demonstrate capability and compliance with requirements.

B. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new unit sand proceed with retesting.

END OF SECTION 23 17 10

SECTION 23 17 30
STRAINERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies strainers used in hydronic piping systems and includes general descriptions and installation methods.

1.3 DEFINITIONS

A. The following are definitions and abbreviations used in this section:

1. ASME - American Society of Mechanical Engineers.
2. ASTM - American Society for Testing and Materials.
3. EPDM - Ethylene Propylene Diene Monomer.
4. NPT - Nominal Pipe Thread.
5. PSI - Pounds per square inch.

1.4 QUALITY ASSURANCE

A. ASME Compliance:

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

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare strainers for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.

B. Use the following precautions during storage:

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

C. Use a sling to handle large strainers; rig sling to avoid damage to exposed parts.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Prepare strainers for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.

B. Use the following precautions during storage:

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

C. Use a sling to handle large strainers; rig sling to avoid damage to exposed parts.

PART 2 - PRODUCTS

2.1 GENERAL

A. Where possible provide all strainers of the same manufacturer. All strainers shall have the manufacturer's name (or trademark) and pressure rating clearly marked on the strainers body.

B. Provide factory-fabricated strainers of types and temperature/pressure ratings as indicated, suitable for the service in which the strainers are installed.

C. Unless otherwise indicated, provide strainers of same size as the pipe in which it is installed.

D. Where strainers are to be insulated, leave cap accessible.

2.2 HYDRONIC STRAINERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide strainers as manufactured by one of the following:

1. Apollo
2. Armstrong
3. Hammond
4. Hydronic Components, Inc. (a division of Jomar)
5. ITT Hoffman
6. Milwaukee
7. Mueller
8. Nibco
9. Spirax Sarco
10. Stockham
11. Watts

B. Strainers 2” and Smaller in Copper pipe:

1. Cast bronze body
2. 304 stainless steel screen:
   a. Sizes ¼” through ½”: 40 mesh, 0.010” wire
   b. Sizes ¾” through 2”: 20 mesh, 0.016” wire
3. Operating pressure/temperature: 400 PSI, at 400°F
4. Brass plug
5. Furnish with threaded connections

C. Strainers 2" and Smaller in Steel pipe:

1. Cast iron body
2. 304 stainless steel screen:
   a. Sizes ¼" through ½": 40 mesh, 0.010" wire
   b. Sizes ¾" through 2": 20 mesh, 0.016" wire
3. Operating pressure/temperature: 400 PSI, at 400°F
4. Malleable iron plug
5. Furnish with threaded connections

D. Strainers 2-1/2" and larger:

1. Cast iron body, ASTM A126-B
2. Cover, carbon steel ASTM A36
3. Gaskets, EPDM (non asbestos)
4. "Y" configuration
5. Class 125 (150 psi at 150 deg F.)
6. Screen shall be type 304 stainless steel with 1/16" (0.062") perforations for sizes 4" and smaller; 1/8" for 5" and larger
7. Furnish with NPT blowdown outlet with ball valve and hose thread cap
8. Furnish with flanged connections

PART 3 - EXECUTION

A. Examine strainer interior for cleanliness, freedom from foreign matter, and corrosion.

B. Examine threads on strainer and mating pipe for form and cleanliness.

C. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

D. Do not attempt to repair defective strainers; replace with new.

3.2 INSTALLATION

A. Strainers shall be installed at the inlet to each pump and elsewhere as indicated on the drawings.

B. Locations and orientation shall be as recommended by the manufacturer for proper operation, and to facilitate proper maintenance access and removal of internal screening apparatus. Install steam strainers horizontally in horizontal pipe.

C. Install all piping with reduction in size being made only at the inlet and outlet of control valves, regulating valves and equipment. All strainers shall be installed full line size.

3.3 ADJUSTING

A. Clean strainer mesh after piping systems have been tested and put into service but before final adjusting and balancing.

END OF SECTION 23 17 30

SECTION 23 18 10
BLADDER TYPE EXPANSION TANKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies bladder type expansion tanks and includes materials, accessories, and basic installation instructions. See drawings for specific sizes and installation requirements pertaining to this project.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 QUALITY ASSURANCE

A. Provide expansion tanks of same type by same manufacturer.

1.4 CODES AND STANDARDS

A. ASME Compliance: Manufacture and install expansion tanks in accordance with ASME B31.9 "Building Services Piping and ASME Section VIII.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

C. Start-up Report:

1. Provide completed start-up form, per the requirements of Section 23 03 20. Indicate charge pressure in report.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept equipment on site in shipping containers with labeling in place. Immediately inspect for damage.

B. Protect components from entry of foreign material be providing temporary end caps and enclosures on piping connections. Maintain in place until installation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide bladder type expansion tanks as manufactured by one of the following:

1. Amtrol, Inc.
2. Bell and Gossett ITT; Fluid Handling Div.
3. John Wood Company (Alco Industries Co.)
4. Patterson Pump Co., a subsidiary of the Gorman-Rupp Co.

5. Taco, Inc.

2.2 GENERAL

A. Provide expansion tank(s) of the size and type as indicated.

2.3 TANKS

A. Tanks shall be welded steel, designed, constructed and stamped in accordance with Section VIII, Division I of ASME Boiler and Pressure Vessel Code.

B. Tanks shall be rated for a maximum working pressure of 125 psi at 240°F.

C. Provide tanks with the minimum acceptance volume and factory precharge pressure as indicated.

2.4 BLADDERS

A. The bladder shall be constructed from a flexible, heavy duty butyl rubber.

B. Where scheduled, provide internal replaceable elastomer bladder.

C. The bladder shall be suitable for a maximum system operating temperature of 240°F.

2.5 ACCESSORIES

A. Units shall be furnished with lifting rings.

B. Units shall have the system connection and charging valve at the tank top and tank drain connection at the bottom.

C. Furnish tanks with a steel base ring where indicated on the drawings to be mounted in a vertical configuration.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which bladder type expansion tanks are to be installed.

B. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION

A. Install bladder type expansion tanks as indicated on the drawings and in accordance with manufacturer's instructions.

B. Charge tank with proper air charge as recommended by manufacturer or indicated.

C. Provide a shutoff isolation valve at each expansion tank connection. Remove handle and wire to valve. Tag valve – "Valve to be closed only by authorized personnel".

3.3 FIELD QUALITY CONTROL

A. Upon completion of installation of bladder type expansion tanks and after units are water pressurized, test units to demonstrate capability and compliance with requirements.

END OF SECTION 23 18 10

SECTION 23 20 10
METAL DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

C. See also Section 23 03 40 for ductwork leakage testing.

1.2 SCOPE

A. Extent of metal ductwork is indicated on drawings and by requirements of this Section. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. SMACNA Standards: Comply with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible" for fabrication and installation of metal ductwork.

B. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" and NFPA 90B "Standard for the Installation of Warm Air Heating and Air Conditioning Systems".

C. ASHRAE Standards: Comply with ASHRAE Handbook, Equipment Volume, Chapter 1 "Duct Construction", for fabrication and installation of metal ductwork. Ductwork shall be sealed and leak tested as required by SMACNA and ASHRAE Standard 90.1.

D. OMC Compliance: Equipment, materials and installation shall comply with the Ohio Mechanical Code and all requirements of the local authorities having jurisdiction.

1.4 QUALIFICATIONS

A. Firms regularly engaged in manufacture of metal ductwork products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

C. Special Requirements

1. Submit 1/4" = 1'-0" scale ductwork shop drawings for review, prior to construction. Ductwork shop drawing shall include elevations of the top of duct for each main trunk and major branch, all transitions indicated, all internally lined sections indicated, flexible duct indicated, duct pressure class and duct seal class indicated, and any obstructions that prevent the ductwork from being installed as indicated on the contract documents.

a. Do not proceed with ductwork fabrication prior to approval of ductwork shop drawings. All work fabricated or erected prior to receipt of approved ductwork shop drawings is so done at the Contractor's risk and is subject to removal and replacement at no cost to the Owner.

b. Upon request, electronic files of ductwork plans in Autocad format may be obtained from the Engineer for development of shop drawings by the sheet metal contractor. A nominal service fee will be charged for processing and email delivery of the files.

c. Photocopied, reproduced or traced drawings of the original contract documents will not be allowed to be used as ductwork shop drawings. Single line drawings of the ductwork layout will not be allowed to be used as ductwork drawings. Electronic files of the original contract documents will not be allowed to be used as ductwork shop drawings.

d. Sheet metal shop drawings shall be submitted separate from coordination drawings.

2. Test and Startup Reports

a. Ductwork Pressure Test Report (23 03 40) – Where specified

b. Balance Report (per section 23 03 30)

1.6 SYSTEM PERFORMANCE REQUIREMENTS

A. The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air systems. Changes or alterations to the layout of configuration of the duct system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure requirements.

B. Duct systems shall be leak-tested by the balancing contractor. The sheetmetal contractor shall provide all labor and material (such as temporary caps at terminal boxes), for balancing contractor to accomplish duct leakage testing.

1.7 DELIVERY, STORAGE AND HANDLING

A. Protection: Protect shop-fabricated and factory-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.

B. Storage: Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide factory-fabricated ductwork and fittings as manufactured by one of the following:

1. LaPine Metal Products
2. Lindab, Inc.
3. Semco Mfg., Inc.
4. Sheet Metal Connectors, Inc.
5. Spiral Manufacturing Co., Inc.
6. Tangent Air
7. United Sheet Metal Div., United McGill Corp.

2.2 GENERAL

A. All manufactured ductwork and fittings shall be constructed and rated per the SMACNA pressure classification rating system for the appropriate system type as defined herein.

2.3 MATERIALS

A. Provide ductwork of materials that are free from visual imperfections including pitting, seam marks, roller marks, stains and discolorations, and other imperfections, including those which would impair painting.

B. Duct Material Schedule:

SYSTEM DESCRIPTION	DUCT MATERIAL
Supply Air and Return Air	Galvanized Steel
Exhaust Air - General	Galvanized Steel
Combustion Air – Fuel-Burning Appliances	Galvanized Steel

C. Galvanized Steel:

1. Galvanized ductwork shall be fabricated of No. 1 prime galvanized sheet metal of lock forming quality, complying with ASTM A527. Galvanized coating shall comply with ASTM A527 and ASTM A924. Evidence of any separation of galvanized surface from the steel at any point of the ductwork shall be considered sufficient cause to reject this material and work.

2. Reinforcement Shapes and Plates: Unless otherwise indicated, provide galvanized steel reinforcing where installed on galvanized sheet metal ducts.

D. Reinforcement Shapes and Plates:

1. Unless otherwise indicated, provide galvanized steel reinforcing where installed on galvanized sheet metal ducts. Provide stainless steel reinforcing where installed on aluminum and stainless steel sheet metal ducts.

E. Tie Rods

1. Galvanized steel, 1/4" minimum diameter for 36" length or less; 3/8" minimum diameter for lengths longer than 36".

2.4 PRESSURE CLASSIFICATIONS

A. Construct sheetmetal air distribution systems in accordance with the following pressure classifications, as defined in ANSI/SMACNA 006-2006 (3rd Edition). If not indicated below, ductwork shall be constructed to minimum 2” pressure classification:

SYSTEM DESCRIPTION	PRESSURE CLASSIFICATION
Supply Air – VAV systems	
Upstream of VAV boxes	6”
Downstream of VAV boxes	2”
Supply – Constant Volume Systems	2”
Return Air (upstream of air handling units)	4”
Return/Transfer Air (plenum return)	2”
Exhaust Air – General	2”

2.5 RECTANGULAR DUCT FABRICATION

A. Fabricate rectangular ducts with galvanized sheet steel in accordance with the latest edition of SMACNA "HVAC Duct Construction Standards", including their associated details. Conform to the requirements in the referenced standard for metal thickness, reinforcing types and intervals, tie rod applications and joint types and intervals.

B. Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification. Preassemble, duct work in shop to greatest extent possible, so as to minimize field assembly of systems. Disassemble systems only to extent necessary for shipping and handling. Match-mark sections for re-assembly and coordinated installation.

C. Rectangular Fittings Fabrication

1. Changes in direction, of all rectangular supply air ductwork and return air and exhaust air ductwork with any one dimension greater than 10 inches, shall be made with full radius elbows with radius equal to 1-1/2 times the horizontal width of the duct, or with square elbows with turning vanes. Turning vanes shall be constructed of the same material as the surrounding ductwork and two (2) gauge numbers heavier.

2. Branch connections shall be 45 degrees entry or bellmouth-type equivalent. Straight taps, clinch locks, dovetail or spin-in branch connections are not permitted. No excess sheetmetal material shall project from the main duct into branch entry taps.

2.6 ROUND AND FLAT OVAL DUCTWORK FABRICATION

A. Round and Flat-Oval Ducts: Fabricate round and flat-oval ducts of SMACNA 2” and 3” W.G. pressure classification with spiral seam, grooved seam or snaplock seam construction. Fabricate round and flat-oval ducts of 4”, 6” and 10” W.G. pressure classification with spiral lock-seam construction or fusion-welded butt seam for longitudinal seam duct. Comply with the latest edition of SMACNA "HVAC Duct Construction Standards", for galvanized steel gauges.

B. Round and Flat Oval Fittings Fabrication

1. All laterals, reducers, tees and elbows shall be continuously welded along all seams.

2. All 45° laterals, 90° branches and tees shall be made with conical or bellmouth fittings. All conical laterals, branches and tees shall be fabricated to conform to the latest edition of SMACNA "HVAC Duct Construction Standards" with metal thicknesses specified for longitudinal seam straight duct.

3. All diverging -flow fittings shall be fabricated with a reduced entrance to branch taps with no excess material projecting from the body into ranch tap entrance. Straight taps, clinch locks, dovetail or spin-in branch connections are not permitted.

4. All laterals, reducers, tees and elbows for ducts of 4”, 6” and 10” W.G. pressure classification shall be continuously welded along all seams.

5. For 2” and 3” w.g. pressure class ductwork, elbows may be adjustable or segmented standing seam with a bend radius of 1.5 times the duct diameter and a maximum 20 degree per section (gore). Apply duct sealant to the interior seams of these elbows.

6. Fabricate elbows for ductwork of 4”, 6” and 10” w.g. pressure class construction in stamped or 5-gored, segmented construction. Segmented elbows shall have each transverse gore continuously welded. Apply sealant to the interior seams of these elbows. Fabricate the bend radius of stamped or 5-gored elbows 1.5 times the duct diameter. Segmented elbows shall not exceed 20 degree change of direction per section (gore).

2.7 HANGERS AND SUPPORTS

A. Building attachments shall be concrete inserts or structural steel fasteners appropriate for building materials. Do not use power actuated concrete fasteners without express written consent of Owner. Do not use power actuated concrete fasteners for lightweight aggregate concretes or for slabs less than 4" thick. "C" type beam clamps may be utilized only with beam retaining straps.

B. Hangers shall be galvanized sheet steel, or round, uncoated steel, with straps and threaded rod sized per SMACNA.

C. Duct attachments shall be made using sheet metal screws, blind rivets or self-tapping metal screws; compatible with duct materials.

D. Support Materials: Provide hot-dipped galvanized steel shapes and plates for galvanized steel ducts.

E. All adhesive hangers shall be approved for use with cracked concrete per the American Concrete Institute and ICC-ES Standard AC308. All mechanical hangers shall be approved for use with cracked concrete per the American Concrete Institute and ICC-ES Standard AC193.

2.8 JOINT SEALANT

A. Acceptable manufacturers: Subject to compliance with requirements, provide ductwork sealing materials as manufactured by one of the following:

1. Monoco Industries
2. 3M
3. United Sheet Metal.
4. Ductmate Industries, Inc.

B. Joint and seam sealant shall be LEED compliant, water-based, have a synthetic latex emulsion base, and comply with UL 181B-M and UL 723.

C. Joint and seam sealing materials shall be non-hardening, non-migrating mastic or liquid elastic, suitable for use with air distribution ductwork.

D. Oil based sealing compounds are not acceptable.

2.9 SURFACE PRE-TREATMENT AND FINISH

A. Where ductwork is to be finish painted in exposed locations, galvanized sheet metal shall be pre-etched type known as "Galvanneal" or "Paint-Grip".

B. Final paint color selection shall be per the Architect, unless noted otherwise.

2.10 MISCELLANEOUS SHEETMETAL

A. Auxiliary (secondary) Drain Pans

1. Fabricate from 18 gauge 304 stainless steel.
2. Exposed sheetmetal edges shall be rolled over to provide a rounded edge for safety of building maintenance personnel.
3. Slope drain pan bottom to drain piping connection location.
4. Weld all seams for water-tight joint.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide all ductwork as indicated on the drawings, making all necessary offsets (whether or not specifically indicated) as required to meet the various building conditions. Ductwork installation shall not conflict with equipment or piping.

B. All changes in cross section shall be made without reducing the design area of the duct.

C. No pipe or other obstructions shall pass through air ducts.

D. Cover exposed ductwork openings with visqueen or duct sock type cap to keep inside of ductwork free of dust, debris, etc. during construction.

E. Ductwork shall be hung from structure; ductwork shall not be hung from equipment, piping, conduit or other ductwork.

F. Provide all manual balancing dampers where indicated on the drawings and where necessary to properly distribute and balance the air.

G. Provide flexible duct connections at all fan inlets and outlets.

H. All ductwork joints and seams shall be air-tight. Poorly made joints, splits, visible holes at corners, etc. shall be reworked and repaired. Where excessive pulsating of ductwork is found, additional stiffeners shall be added. Any cracking in the sealant that is apparent upon inspection shall be sufficient to warrant rejection.

I. If the interior of sheet metal is exposed to view through air distribution devices in finished areas of the building, it shall be coated with primer and a flat black finish coat.

3.2 INSTALLATION

A. Install metal ductwork in accordance with SMACNA HVAC Duct Construction Standards. Assemble and install ductwork in accordance with recognized industry practices which will achieve air-tight and noiseless systems, capable of performing each indicated service. Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth.

B. Install ductwork runs above ceilings so as to maintain design ceiling heights. Exposed ductwork shall be installed to provide maximum headroom.

C. All ductwork shall be supported per SMACNA requirements.

D. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and to prevent buckling. Support vertical ducts at every floor. Install couplings tight to duct surface with projections into duct at connections kept to a minimum.

E. Complete field fabrication of work at project as necessary to match shop-fabricated work and accommodate installation requirements.

F. Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct useable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns and other structural and permanent enclosure elements of building. Limit clearance to 1" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1" clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

G. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gauge as duct. Overlap opening on 4 sides by at least 1-1/2".

H. Coordinate duct installation with installation of accessories, fans, dampers, coil frames, equipment, controls and other associated work of ductwork system.

3.3 HANGING AND SUPPORTING

A. Install rigid round and rectangular metal duct with support systems indicated in SMACNA "HVAC Duct Construction Standards", Tables 4-1 through 4-3 and Figures 4-1 through 4-8.

B. Support horizontal ducts with 2 feet of each elbow and within 4 feet of each branch intersection.

C. Support vertical ducts at a maximum interval of 16 feet and at each floor.

D. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicated.

E. Install concrete insert prior to placing concrete.

3.4 DUCTWORK SEALING REQUIREMENTS

A. Duct sealant shall be furnished and installed in accordance with SMACNA Standards at an application temperature between 35° F to 110° F.

B. All ductwork shall be sealed per SMACNA Standards:

Table 23 20 10.1

Duct Class	Seal Class	Sealing Applicable
1/2-, 1-, 2-in wg	C	Transverse Joints Only
3-in wg	B	Transverse Joints and Seams
4-, 6-, 10-in wg	A	Joints, Seams and All Wall Penetrations

C. Seal and pressure test externally insulated ducts prior to insulation installation with two coats of sealant.

D. Helical (spiral) lock seams do not have to be sealed.

E. Return air boots are not required to be sealed.

F. Longitudal seams of all outdoor ducts shall be on the bottom of the ducts and the ducts shall be sealed water tight.

3.5 ADJUSTING, CLEANING, AND PAINTING

A. Clean ductwork internally, unit by unit as it is installed, of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal.

B. At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.

C. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for air distribution testing and balancing of metal ductwork; not work of this Section. Seal any leaks in ductwork that become apparent in duct leakage tests or balancing process.

D. Exterior, uninsulated ducts shall be painted.

3.6 DUCT MOUNTED SMOKE DETECTOR INSTALLATION

A. Duct mounted smoke detectors shall be provided by the Electrical Contractor and mounted in the duct by the HVAC Contractor.

B. Electrical Contractor shall coordinate the mounting location of the smoke detector with the HVAC Contractor. Exact location shall be determined by the HVAC Contractor. Location shall be in accordance with NFPA 72 and the smoke detector manufacture's requirements. Smoke detector location must be accessible for service and maintenance.

C. If the determined smoke detector location requires additional mounting provisions to permit proper installation, the provisions shall be provided and installed by the HVAC Contractor. Minimum duct sizes for installation of duct smoke detector are typically 18" for round and 8" square for rectangular. Provide transitions to sections that meet these minimum requirements. Verify requirements with actual duct detector being furnished by Division 26.

END OF SECTION 23 20 10

SECTION 23 20 20
FLEXIBLE DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies flexible ductwork and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. All ductwork shall be constructed and installed per the following requirements:

1. SMACNA "HVAC Duct Construction Standards, Metal and Flexible"

2. ASHRAE standards for duct construction.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products as manufactured by one of the following:

1. Flexmaster U.S.A. Inc.

2. Thermaflex

3. equal to Flexmaster type 8.

2.2 CONSTRUCTION

A. Tested and classified by Underwriters Laboratories, Inc. as Class 1 Air Duct and labeled in accordance with UL 181, "Standard for Air Ducts". The flame spread rating shall be 25 or less and the smoke developed rating shall be 50 or less.

B. Liner shall be constructed of CPE (polyethylene), mechanically locked without adhesives, Helix shall be galvanized steel, formed and mechanically locked to fabric.

C. For low pressure ductwork systems, flexible ductwork shall be rated for 6 inch water column.

D. For high pressure ductwork systems, flexible ductwork shall be rated for 10 inch water column.

2.3 INSULATION

A. Where ductwork is to be insulated, liner shall be covered by a factory wrapped, 1-1/2" thick, 3/4 pound density fiberglass insulation blanket.

B. Vapor Barrier (outer jacket) shall be black fire retardant polyethylene material, which shall not age harden.

2.4 ACOUSTICAL PROPERTIES

A. Acoustical flex ducts shall be minimum 3'-0" long/maximum 5'-0" with the following insertion loss acoustical performance for a 3'-0" length:

Insertion Loss, dB								
Size	Arrangement	Octave Band Center Frequency, HZ						
		63	125	250	500	1000	2000	4000
6”	Straight	1	2	8.7	9.6	10.2	10.5	8
8”	Straight	3	4	10	11	11	11	6
12	Straight	4	5	8.1	6.9	8.4	8	4
6”	90 deg Elbow	1	2	8	9.9	11.1	10.8	9
8”	90 deg Elbow	3	4	9	12	11	11	7
12”	90 deg Elbow	3	4	7.8	9	9.3	9.3	4

2.5 FLEXIBLE DUCT CONNECTORS

A. Provide commercial grade fabric/metal products as manufactured by one of the following:

1. Duro-Dyne
2. Ductmate Industries, Inc.
3. Or approved equal.

B. Commercial grade fabric/metal products shall be designed to meet NFPA 701, NFPA 90A, and NFPA 90B.

C. Commercial grade fabric/metal products (standard roll length of 100 feet) shall be airtight and waterproof and utilize 24 gauge galvanized steel meeting ASTM-A-525 G60.

D. Base fabric shall be woven fiberglass with vinyl super duty, neoprene commercial, Hypalon, silicone rubber, or Teflon coating.

E. “Grip Loc” double-lock gripping fingers for increased holding power at metal-to-fabric for industrial/commercial applications.

PART 3 - EXECUTION

3.1 GENERAL

A. Install flexible ductwork fully extended, free of sags and kinks. Minimum length of flexible ductwork shall be 3'-0". Maximum length of flexible ductwork shall be 5'-0". Fasten flexible ductwork to rigid ductwork and devices with self-locking 100 percent nylon, adjustable diameter clamps.

B. Provide flexible duct connection at all fan inlets and outlets.

C. Install all equipment as indicated on the drawings and in accordance with the manufacturer's installation instructions.

3.2 FLEXIBLE DUCT CONNECTOR INSTALLATION

A. Stiffen, install, and seal corners/seams per manufacturer's recommendations. For airtight connection, apply duct sealer over metal joint.

END OF SECTION 23 20 20

SECTION 23 20 50
BREECHINGS AND VENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

C. Related Sections: Refer to other Sections of Division 23 for insulation of breechings.

1.2 SUMMARY

A. This Section specifies vents and breechings for fuel burning appliances and includes materials and installation requirements. Extent of work required by this Section is indicated on drawings and by requirements of this Section.

B. This Section specifies single wall metal vents and accessories for gas-fired appliances.

C. This Section specifies double wall metal vents and accessories for gas-fired appliances.

D. This Section specifies single wall, positive pressure vents and accessories for gas-fired appliances.

E. This Section specifies double wall, positive pressure vents and accessories for gas-fired appliances.

F. This Section specifies field fabricated metal breechings.

1.3 QUALITY ASSURANCE

A. Codes and Standards:

1. NFPA: Comply with NFPA 211 "Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances."

2. UL: Comply with appliances portions of UL safety standards; provide products which have been UL listed and labeled.

3. SMACNA: Comply with SMACNA Duct Construction Standards for fabricated breechings and smokepipe.

4. AWS: Comply with AWS Structural Welding Code for welders' qualifications, welding details, and workmanship standards.

5. ASHRAE: Comply with the ASHRAE Equipment Handbook, Chapter 6, for Chimney, Gas Vent, and Fireplace Systems, material requirements and design criteria.

6. National Fuel Gas Code: Comply with National Fuel Gas code for gas vents and breechings.

B. Materials and installation shall comply with the appliance manufacturer's written venting guides and installation manuals, Local Mechanical Code and all requirements of the local authorities having jurisdiction.

C. Welders Qualifications: All welders shall be certified in accordance with AWS Standard D9.1, Specifications for Welding Sheet Metal.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 MATERIAL SCHEDULE

A. The table below identifies the acceptable breeching and vent materials allowed for this project. Where multiple options are listed, the option used shall be at the discretion of the Contractor.

Description	Material
Boiler Flue Vent	Factory Fabricated Positive Pressure Single Wall Metal Vents with field applied insulation
	Factory Fabricated Positive Pressure Double Wall Metal Vents (AL-29-4C, type 444 SS or type 316L SS inner liner (**note: vent material must be approved by boiler manufacturer, only AL-29-4C is approved by Aerco**)
	Field Fabricated Metal Breechings and Vents
Domestic Water Heater Flue Vent	Factory Fabricated Positive Pressure Single Wall Metal Vents with field applied insulation
	Factory Fabricated Positive Pressure Double Wall Metal Vents (AL-29-4C, type 444 SS or type 316L SS inner liner) (**note: vent material must be approved by domestic water heater manufacturer, only AL-29-4C is approved by Aerco**)
	Polypropylene Piping
	CPVC Piping
Condensing Appliance Flue Vent (Forced-air Furnaces, Duct Furnaces, Unit Heaters)	Polypropylene Piping
	CPVC Piping
Combustion Air	Metal Ductwork (section 23 20 10)
	PVC pipe (as allowed by the appliance manufacturer
Boiler Flue – Horizontal sections in mechanical room	Factory Fabricated Double Wall Metal Vents
Boiler Flue – Vertical sections in chase	Factory Fabricated Double Wall Metal Vents

2.2 FACTORY – FABRICATED SINGLE-WALL METAL VENTS (B-VENTS)

A. Available Manufacturers: Subject to compliance with requirements, provide Type B double wall gas vents as manufactured by one of the following:

1. American Metal Products Co.; Div. of Masco Corp.
2. General Products Co., Inc.
3. Hart & Cooley Mfg. Co.
4. Metal-Fab Inc.
5. Pro-Tech Systems, Inc./DuraVent (M&G Group)
6. Security Chimneys International
7. Selkirk Metalbestos

B. Provide single-wall metal vents for use with approved Category I appliances, burning natural gas.

C. Vents shall be constructed of galvanized sheet steel not less than 0.03 inches thick.

D. All fittings, tees, elbows, increases, flashing, storm collars, caps with bird barrier, thimbles, appliance adapter draft hood connectors, support assemblies, fire stop spacers, fasteners, etc. required for a complete installation shall be included and furnished by the manufacturer.

E. Vents shall terminate as required by code.

2.3 FACTORY FABRICATED DOUBLE-WALL METAL VENTS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide single wall gas vents as manufactured by one of the following:

1. American Metal Products Co.; Div. of Masco Corp.
2. General Products Co., Inc.
3. Hart & Cooley Mfg. Co.
4. Metal-Fab Inc.
5. Pro-Tech Systems, Inc./DuraVent (M&G Group)
6. Security Chimneys International
7. Selkirk Metalbestos

B. Provide UL 1738 listed double wall, factory built metal vent for use with appliances burning natural gas. Double wall gas vents shall be capable of handling continuous 550°F flue gas temperatures.

C. The Vents shall be constructed of an outer wall of minimum 0.024" thick galvanized steel, an integral annular air space, and an inner wall of AL-29-4C aluminum alloy, or minimum 0.035" thick type 304, type 444, or type 316L stainless steel.

D. All fittings, tees, elbows, increases, flashing, storm collars, caps with bird barrier, thimbles, appliance adapter draft hood connectors, support assemblies, fire stop spacers, fasteners, etc. required for a complete installation shall be included and furnished by the manufacturer.

E. Vents shall terminate as required by code.

2.4 FACTORY FABRICATED POSITIVE PRESSURE SINGLE-WALL VENTS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products as manufactured by one of the following:

1. Metal-Fab Inc.
2. Pro-Tech Systems, Inc./DuraVent (M&G Group)
3. Schebler Co.

4. Security Chimneys International

B. Positive pressure vents shall be of the single wall, factory-built type, designed for use in conjunction with Category II, III, or IV (UL 1738) condensing or non-condensing gas fired appliances or as specified by the heating equipment manufacturer.

C. Positive pressure vents shall be capable of handling a continuous flue gas temperature not exceeding 550°F.

D. Positive pressure vents shall be listed for a maximum positive pressure rating of 6" w.c. and shall have passed at 15" w.c.

E. The positive pressure vent system shall be continuous from the appliance's flue outlet to the vent termination outside the building. All system components shall be UL 1738 /cUL listed and supplied by the same manufacturer.

F. Positive pressure vents shall be constructed of stainless steel, with a min. wall thickness of 0.061" for 3" through 7" dia. vents, 0.019" for 8" through 12" dia. vents and 0.024" for 14" and 16" dia. vents.

G. All system components such as vent supports, roof or wall penetrations, terminations, appliance connectors, and drain fittings required to install the vent system shall be UL listed and provided by the vent manufacturer.

H. All system components shall include a factory- installed gasket in their female-end to render the vent air and water tight when the male/female ends are pushed together as per manufacturer's instructions. Vent systems requiring field installed sealants or compounds shall not be acceptable.

I. All system components shall include a factory installed, internal mechanical locking band for fastening and securing all vent components against each other.

J. Vent layout shall be designed and installed in compliance with manufacturer's installation instructions and all applicable local codes.

2.5 FACTORY FABRICATED POSITIVE PRESSURE DOUBLE-WALL METAL VENTS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products as manufactured by one of the following:

1. Metal-Fab Inc.

2. Pro-Tech Systems, Inc./DuraVent (M&G Group)

3. Schebler Co.

4. Security Chimneys International

5. Selkirk Metalbestos

B. Vents shall be UL listed double wall, factory built metal vents for use with approved Category III appliances burning gaseous or liquid fuels.

C. Vents shall be constructed of an outer wall of aluminized steel, an integral annular air space and an inner wall of type 304 stainless steel.

D. Where indicated on the drawings, the annular space shall be filled with insulation.

E. All inner pipe joints shall be held together by means of formed vee bands and sealant as specified in the manufacturer's recommendations.

F. All roof penetrations, terminations, appliance adapters, thimbles drain fittings, expansion joints, etc. required for a complete installation shall be included and furnished by the manufacturer.

2.6 PLASTIC FLUE PIPING

A. Plastic pipe shall be permitted to be used for venting appliances listed for use with such venting materials. The indicated materials may be used subject to manufacturer's approval and expected maximum flue gas temperature.

Material	Maximum Flue Gas Temperature
PVC Schedule 40	140° F
ABS Schedule 40	160° F
CPVC Schedule 40, 80	180° F
Polypropylene	230° F

B. Cellular (foam) core piping shall not be used for venting purposes.

2.7 FIELD FABRICATED METAL BREECHINGS AND VENTS

A. Materials:

1. Black, carbon, hot-rolled steel complying with ASTM A-569.
2. Minimum gauges for corresponding sizes as indicated (diameter or longest side dimension):

Sizes	Thickness - Gauge
Up to 12"	18
13" to 24"	16
25" to 36"	14
37" to 60"	12
Over 60"	10

B. Fabrication:

1. Fabricate section, fittings and accessories as individual pieces or in combination lengths for field handling.
2. Fabricate breechings with support lug for attachment to building structure so as not to exceed permissible loading at boiler or appliance.
3. Shop fabricate breechings in as complete as possible sections to minimize field welding. Match-mark sections for field assembly and coordination of installation.
4. All longitudinal seams shall be continuously welded.
5. End joints shall be welded or gasketed with companion flanges.
6. Reinforcements: Reinforce rectangular breechings with angle frames as follows for corresponding long side dimensions; and reinforce round breechings with either flanged girth joints or angle frames as follows for corresponding diameter.

Size	Reinforcing	Interval
Up to 30"	No reinforcing required	-
31" to 36"	1-1/2" x 1-1/2" x 3/16"	30" o.c.
37" to 60"	2" x 2" x 1/4"	30" o.c.

Over 60"	3" x 3" x 1/2"	30" o.c.

7. Fabricate breeching fittings to match adjoining materials. Except as otherwise indicated, fabricate elbows with centerline radius equal to 1-1/2 times associated breeching width. Limit angular tapers to 20 degrees maximum for expanding tapers. Install accessories during fabrication to greatest extent possible.

C. Accessories and Specialties

1. Provide accessories and specialties of types and sizes required to comply with breeching requirements including proper connection of equipment.

2. Install barometric dampers, adjustable and self-actuating draft dampers, where indicated, full size of breeching.

PART 3 - EXECUTION

3.1 GENERAL

A. Store delivered materials inside, out of the weather. Protect materials from accidental damage.

B. Installation shall conform to the manufacturer's installation instructions, UL listing (where applicable) and state and local codes.

C. Furnish breechings and vents per the table in Part 2.

3.2 VENT SYSTEM LAYOUT

A. The vent system shall be routed to maintain minimum clearance to combustibles as specified by the manufacturer.

B. Vent Installation shall conform to the manufacturer’s installation instructions, its UL listing and state/local codes.

C. The vent system and breechings shall be inspected and cleaned before the final connection to the appliances.

3.3 METAL VENTS AND BREECHINGS

A. Single-wall metal vent shall not originate in any unoccupied attic or concealed space and shall not pass through any attic, inside wall, concealed space or floor, or at roof penetration.

B. Support all metal vents from building structure by welding, bolting, steel expansion anchors, or concrete inserts per manufacturer's installation instructions. Size of structural shapes shall be in accordance with manufacturer's recommendations.

C. Cap all open ends of metal vents during construction to prevent entrance of dust, debris, etc.

D. Clean all metal vents of dust and debris prior to final connection to appliances.

E. Roof penetrations shall be made with manufacturer’s factory fabricated terminations.

F. For condensing boilers and appliances, pipe all low points and the bottom of vertical risers to condensate neutralizer.

3.4 PLASTIC FLUE PIPING

A. Plastic flue piping shall be supported as per manufacturer's recommendations. Install piping and terminate as required by the appliance manufacturer’s recommendations.

B. Cap all open ends of piping during construction to prevent entrance of dust, debris, etc.

C. Clean all plastic piping of dust and debris prior to final connection to appliances.

D. Metal flue piping shall be utilized for the first 20 feet from the appliance connection when installing plastic pipe and the appliance is capable of working in non-condensing mode.

E. Use starter CPVC pipe section for appliance connection when installing PVC pipe.

END OF SECTION 23 20 50

SECTION 23 21 10
EXTERNAL DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

C. Interior ductliner insulation is specified in other Division 23 Specifications.

1.2 SCOPE

A. This Section specifies duct insulation materials and installation methods common to more than one section of Division 23.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all insulation work described in this Section.

1.3 CODES AND STANDARDS

A. Provide all insulation materials (insulation, jackets, fitting covers, adhesives, cements, mastics, sealers and finishes) with a flame-spread index of 25 or less and smoke developed index of 50 or less, as tested under procedure ASTM E-84 (NFPA 255).

1.4 QUALITY ASSURANCE

A. Installing contractor shall have at least 3 years successful installation experience on projects with mechanical insulation similar to that required for this project.

B. Insulation thickness shall meet the requirements of ASHRAE Standard 90.1.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Unless otherwise noted, and subject to compliance with Specifications, provide insulation materials from the manufacturers specified below:

1. Fiberglass Wrap
    a. Johns Manville
    b. Knauf Insulation
    c. Manson Insulation
    d. Owens Corning
2. Rigid Fiberglass
    a. Johns Manville
    b. Knauf Insulation

c. Manson Insulation

d. Owens Corning

3. Jacketing System

a. Venture Clad ® 1577CW-WE – Manufactured by Venture Tape Corp

b. Flexclad 400 – Manufactured by MFM Building Products

2.2 GENERAL

A. Provide all insulation materials (insulation, jackets, fitting covers, adhesives, cements, mastics, sealers and finishes) with a flame-spread index of 25 or less and smoke developed index of 50 or less, as tested under procedure ASTM E-84 (NFPA 255).

2.3 FIBERGLASS WRAP

A. Fiberglass ductwrap shall have a density of 1.0 lbs per cubic foot.

B. Fiberglass ductwrap shall have an foil-scrim-kraft (FSK) jacket.

C. Install fiberglass ductwrap per the following insulation schedule:

Table 23 21 10.1

Ductwork Insulation Schedule (Fiberglass Duct Wrap)	
Duct Type	**Insulation Thickness**
Concealed Supply Air (including sound attenuators, diffuser plenums, downstream of heat pumps, and outside ventilation air from energy recovery units)	2”
Combustion Air	
Concealed Outside Air	
Concealed Mixed Air	
Concealed Relief Air (between plenum/louver and the relief air control/ back draft damper)	

2.4 RIGID FIBERGLASS

A. Rigid fiberglass insulation shall have a density of 3.0 lbs per cubic foot.

B. Rigid fiberglass insulation shall comply with ASTM C 612, Type IA or Type IB.

C. Rigid fiberglass insulation shall have an all service jacket.

D. Install rigid fiberglass insulation per the following insulation schedule:

Table 23 21 10.2

Ductwork Insulation Schedule (Rigid Fiberglass)	
Duct Type	**Insulation Thickness**
Exposed Supply Air (in non-air conditioned spaces)	2”
Exposed Return Air (in non-air conditioned spaces)	
Supply Air (within mechanical rooms)	
Return Air (within mechanical rooms)	
Exposed Outside Air (in non-air conditioned spaces)	
Exposed Mixed Air (in non-air conditioned spaces)	
Outside Air (within mechanical rooms)	
Mixed Air (within mechanical rooms)	

Ductwork Insulation Schedule (Rigid Fiberglass)	
Duct Type	**Insulation Thickness**
Exposed Relief Air (in non-air conditioned spaces between the plenum/louver and the relief air control/back draft damper	
Relief Air (within mechanical rooms between the plenum/louver and the relief air control/back draft damper)	
Supply Air (exterior)	3”
Return Air (exterior)	
Exhaust Air (exterior)	

2.5 JACKETING SYSTEM

A. In addition to the specified insulation, all exterior ductwork shall be covered with a prefabricated self-adhering, sheet-type waterproofing membrane. The membrane shall be UV-resistant, exceed a 25/50 flame/smoke rating, and be designed specifically for exterior use.

B. The entire jacketing system shall be rated specifically for exterior use.

C. Provide jacketing system with a white/white embossed finish.

D. Follow manufacturer’s recommended installation instructions.

E. Acceptable waterproofing membrane products: Flexclad 400 manufactured by MFM Building Products Corp., VentrueClad 1577 CW manufactured by Venture Tape Corp.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Maintain integrity of vapor-barrier on ductwork insulation.

B. Install ductwork insulation continuous through all wall, floor and ceiling penetrations, except at fire and/or smoke damper locations.

C. Impale rigid duct insulation over welded pins at maximum of 12 inches on center and secure with self-locking caps. Seal all insulation edges and butt joints firmly with 5 inch wide pressure sensitive joint sealing tape.

D. Wrap faced duct wrap insulation tightly on the ductwork with all circumferential joints butted and longitudinal joints overlapped a minimum of 2 inches. Adhere insulation to metal with 4 inch strips of insulation bonding adhesive at 8 inches on center. Additionally secure insulation to the bottom of rectangular ductwork over 24 inches wide with mechanical fasteners at not more than 18 inches on center. Secure facing for circumferential and longitudinal joints using reinforced Kraft tape. Tape all pin penetrations or punctures in facing.

E. Except on supply and return air ductwork installed outside and as otherwise noted, omit exterior duct insulation where internal duct lining is installed.

3.2 DELIVERY, STORAGE, HANDLING

A. Deliver insulation, coverings, cements, adhesives and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.

B. Protect insulation against dirt, water, chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

C. Replace damaged insulation which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.

D. The insulation installer shall advise the General Contractor as to requirements for protection of the insulation work during the remainder of the construction period (after the installation of insulation), to avoid damage and deterioration of the finished insulation work.

3.3 JACKETING SYSTEM

A. Furnish duct jacketing system for all ductwork installed outdoors.

B. Jacketing system shall be installed to provide a weather proof protective membrane. Install jacket on all duct surfaces and overlap joints to promote water shedding.

END OF SECTION 23 21 10

SECTION 23 21 20
INTERNAL DUCTWORK LINER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies internal ductwork liner and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. Provide all insulation materials (insulation, jackets, fitting covers, adhesives, cements, mastics, sealers and finishes) with a flame-spread index of 25 or less and smoke developed index of 50 or less, as tested under procedure ASTM E-84 (NFPA 255).

1.4 QUALITY ASSURANCE

A. Installing contractor shall have at least 3 years successful installation experience on projects with mechanical insulation similar to that required for this project.

B. Insulation thickness shall meet the requirements of ASHRAE Standard 90.1.

1.5 DELIVERY, STORAGE, HANDLING

A. Deliver insulation, coverings, cements, adhesives and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.

B. Protect insulation against dirt, water, chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

C. Replace damaged insulation which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.

D. The insulation installer shall advise the General Contractor as to requirements for protection of the insulation work during the remainder of the construction period (after the installation of insulation), to avoid damage and deterioration of the finished insulation work.

1.6 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide acoustical duct lining as manufactured by one of the following:

1. Nomaco K-Flex Gray Duct Liner

2. Equal product as manufactured by Armacell.

2.2 ACOUSTICAL LINER

A. Internal duct lining shall be one-inch thick, flexible closed-cell polymeric roll insulation, complying with ASTM C1534-02 Duct Liner Specification and NFPA 90a and NFPA 90b.

B. Flexible, non-porous, and non-fibrous duct liner that is moisture, mold and mildew resistant. Density ranging from 2 lb/ft^3, maximum thermal conductivity (k) of 0.27 $Btu\text{-}in/hr\text{-}ft^2\text{-}F°$ at 75°F mean temperature, maximum water vapor transmission rate of 0.10 Perm-in, and minimum sound absorption coefficient of 0.50 at a nominal 1" thickness. Coating shall include an immobilized EPA-registered antimicrobial agent which will not support the growth of fungus, mold or bacteria. Coating shall be tested in accordance with the requirements of ASTM G21 and G22, and UL181. Water vapor absorption shall be less than 0.05% by weight at 120°F, 95% RH.

C. "K-Factor" equal to 0.26 or better, at a mean temperature of 75°F, ASTM C177. Maximum operating temperature shall be 220°F.

D. Flame spread index shall be 25 or less and smoke developed index shall be 50 or less, as tested in accordance with ASTM E 84.

2.3 ADHESIVE

A. Duct lining adhesive shall comply with ASTM C 916 "Specifications for Adhesives for Duct Thermal Insulation". Duct lining fasteners shall comply with SMACNA Duct Construction Standards, Article S2.11.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and adhere to inside of ductwork per manufacturer's installation instructions.

END OF SECTION 23 21 20

SECTION 23 22 10
GRILLES AND DIFFUSERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies air distribution equipment and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. All ductwork shall be constructed and installed per the following requirements:

1. SMACNA "HVAC Duct Construction Standards, Metal and Flexible"

2. ASHRAE standards for duct construction.

B. Equipment, materials and installation shall comply with the applicable Mechanical Code and all requirements of the local authorities having jurisdiction.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products as manufactured by one of the following:

1. Titus

2. Krueger

3. Price

2.2 GENERAL

A. Provide grilles and diffusers where shown on the drawings, of size, type and material as indicated by model numbers in the schedules and as required for a complete installation.

B. Border types shall be compatible with the ceilings, walls, and floors where the grilles and diffusers are to be installed.

C. Where necessary for proper installation, provide plaster frame for installation of diffusers in plaster or drywall ceilings. Furnish with mounting system allowing no exposed fasteners.

D. Refer to Architectural Drawings for exact location of grilles and diffusers.

E. Performance

1. Unless noted otherwise on the drawings, grilles and diffusers shall not exceed a noise criteria of NC 25 at their design operating maximum airflow.

2.3 STAMPED METAL GRILLES

A. Construction

1. Construct of steel

2. Orient blades parallel to long dimension for ceiling applications, orient parallel with floor for wall mounted applications.

B. Finish

1. All stamped metal grilles and diffusers shall be finished with a custom color, factory applied powder coat finish, unless noted otherwise on the drawings. Color selection shall be as scheduled.

2.4 SUPPLY AIR DIFFUSER PLENUMS

A. Construction

1. Zinc coated steel with ½" thick fiber free foam insulation. Plenums shall be oversized to maintain open free area inside plenum.

PART 3 - EXECUTION

3.1 GENERAL

A. All grilles and diffusers shall be supported per SMACNA requirements.

B. Install all equipment as indicated on the drawings and in accordance with the manufacturer's installation instructions. Refer to Architectural Drawings for exact location of grilles and diffusers.

C. Mechanical Contractor shall locate all grille and diffuser positions and dimensions and coordinate requirements with the General Contractor. The Mechanical Contractor shall install grilles and diffusers.

3.2 ADJUSTING AND CLEANING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

B. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 23 22 10

SECTION 23 22 20
DUCTWORK ACCESS DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies ductwork access doors and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. All ductwork shall be constructed and installed per the following requirements:

1. SMACNA "HVAC Duct Construction Standards, Metal and Flexible"

2. ASHRAE standards for duct construction.

B. Equipment, materials and installation shall comply with the Local Mechanical Code and all requirements of the local authorities having jurisdiction.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products as manufactured by one of the following:

1. Air Balance, Inc.

2. Diro Dyne Corp.

3. Ruskin Mfg. Co.

4. Ventfabrics, Inc.

5. Zurn Industries, Inc.; Air Systems Div.

2.2 CONSTRUCTION

A. Construct access doors of same or greater gauge as ductwork served. Access doors shall be rated for the duct pressure classification in which they are installed. Provide flush frames for uninsulated ductwork; extended frames for externally insulated duct (same thickness as insulation).

B. Access doors shall be provided with a gasket and shall be completely removable by the use of two or more cam lock type latches.

C. Minimum size of access doors shall be 2" less than width or height of duct (at location where access door is installed) by 18" in length up to a maximum of 18" x 24".

D. Where ductwork is externally insulated or internally lined, access doors shall be double wall (metal construction) with insulation.

E. Access doors shall be provided with wire reinforced glass window where indicated on drawings.

F. Access doors shall comply with SMACNA "HVAC Duct Construction Standards, Metal and Flexible". Pressure rating shall meet or exceed pressure classification of ductwork.

2.3 LINING

PART 3 - EXECUTION

3.1 GENERAL

A. Provide all duct accessories as indicated on the drawings. Duct accessories installation shall not conflict with equipment or piping.

B. All air distribution equipment shall be supported per SMACNA requirements.

C. Install all equipment as indicated on the drawings and in accordance with the manufacturer's installation instructions.

3.2 INSTALLATION

A. Install duct access doors at all fire damper, smoke damper, and combination fire/smoke damper locations for fusible link repair. Install duct access doors at all balancing damper locations for balancing dampers greater than 18" in any dimension and having linkage internal to ductwork.

B. Install duct access doors at upstream side of all reheat coils.

C. Locate duct access doors for easiest accessibility to fire dampers and coils. Coordinate locations, and sizes of drywall ceiling access doors and shaft access doors (provided by General Trades) to line-up with duct access doors.

3.3 ADJUSTING AND CLEANING

A. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 23 22 20

SECTION 23 22 30
MANUAL BALANCE DAMPERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies ductwork and air distribution equipment and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. All ductwork shall be constructed and installed per the following requirements:

1. SMACNA "HVAC Duct Construction Standards, Metal and Flexible"
2. ASHRAE standards for duct construction.
3. AMCA Standard 500-D.

B. Equipment, materials and installation shall comply with the Local Mechanical Code and all requirements of the local authorities having jurisdiction.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 BALANCING DAMPERS

A. Acceptable Manufacturers

1. Air Balance, Inc.
2. American Warming and Ventilating, Inc.
3. Arrow Louver and Damper; Div. of Arrow United Industries, Inc.
4. Greenheck
5. Metropolitan Air Technology
6. Ruskin
7. Tamco

B. Round dampers shall consist of:

1. Single-blade type construction.
2. Minimum 18 gauge galvanized steel.

3. Suitable for the ductwork pressure classification in which they are installed.

4. Pivot rod shaft shall be continuous through cross section of duct.

5. Furnish all round balancing dampers with Young Regulator Company 403, 403B, 443 or 443B series Valcalox regulators with handle permanently attached. Damper handle position shall be securely locked in place by tightening of a lock nut. Where ductwork is externally insulated, regulator base height shall accommodate insulation thickness (Young Regulator Company 443 or 443B series Valcalox regulators). Regulator shall be clearly marked to indicate damper position

C. Rectangular dampers 8"x8" and smaller shall be single blade; dampers larger than 8"x8" shall be multi-blade (opposed blade) type. Dampers shall consist of:

1. 16 gauge galvanized steel hat channel frame with 5" depth.

2. Triple V-type blades fabricated from 16 gauge galvanized steel.

3. 1/2" diameter plated steel axles.

4. External (out of airstream) blade-to-blade linkage.

5. Dampers shall be suitable for the ductwork pressure classification in which they are installed.

6. Furnish with standard 1-1/2" standoff bracket (optional 2" standoff bracket where ductwork is externally insulated, regulator base height shall accommodate insulation thickness) and 1/2" locking manual quadrant with handle permanently attached. Damper handle position shall be securely locked in place by tightening of a lock nut. Regulator shall be clearly marked to indicate damper position.

D. Seals shall be provided on all balancing dampers installed in 3 inch water column pressure class ductwork and higher.

E. All balancing dampers shall be constructed in accordance with SMACNA "HVAC Duct Construction standards".

PART 3 - EXECUTION

3.1 GENERAL

A. Provide all duct accessories as indicated on the drawings. Duct accessories installation shall not conflict with equipment or piping.

B. Provide all manual balancing dampers where indicated on the drawings and where necessary to properly distribute and balance the air.

C. All air distribution equipment shall be supported per SMACNA requirements.

D. Install all equipment as indicated on the drawings and in accordance with the manufacturer's installation instructions.

3.2 ADJUSTING AND CLEANING

A. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 23 22 30

SECTION 23 22 35
GRAVITY BACKDRAFT DAMPERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies gravity backdraft dampers and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

C. Extent of work required for gravity backdraft dampers is indicated by drawings and schedules and as specified herein.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of gravity backdraft dampers, of types, ratings and capacities required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 CODES AND STANDARDS

A. NEMA Compliance: Provide electrical accessories complying with NEMA standards.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Sections 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver gravity backdraft dampers in factory-fabricated crates, containers or wrappings which properly protect gravity backdraft dampers from damage.

B. Store gravity backdraft dampers in original packaging and protect from weather and construction traffic. Wherever possible, store in doors. Where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle gravity backdraft dampers carefully to prevent damage, breaking, denting and scoring of finishes. Do not install damaged units or components; replace with new.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide gravity backdraft dampers as manufactured by one of the following:

1. Air Balance, Inc.

2. American Warming and Ventilating, Inc.

3. Arrow Louver and Damper; Div. of Arrow United Industries, Inc.
4. Greenheck
5. Ruskin Mfg. Co.
6. Tamco

2.2 GENERAL

A. For all applications where the air velocity is less than 1,000 fpm, provide silent operating dampers with parallel blades, counterbalanced to relieve at an adjustable static relief pressure range of 0.01" to 0.05" w.g. Construct blades of 0.025" formed aluminum with plastic edge seals and ball or synthetic bearings. Construct frame of 16 gauge steel channel or 0.05" wall extruded aluminum channel. Provide galvanized steel finish on all steel parts. Leakage rate shall not exceed 20 cfm/square foot at 1.0" w.g. pressure.

B. For all applications where the air velocity ranges from 1000 to 2500 fpm, provide silent operating dampers with parallel blades, counter balanced to relieve at an adjustable static relief pressure range of 0.02" to 0.06" w.g. Construct blades of 0.05" formed aluminum with plastic edge seals and ball or synthetic bearings. Construct frame of 10 gauge steel channel or 0.125" wall extruded aluminum channel. Provide galvanized steel finish on all steel parts. Leakage rate shall not exceed 20 cfm/square foot at 1.0 w.g. pressure.

2.3 PERFORMANCE

A. Dampers shall have a maximum differential pressure rating of 5 in. wg.

B. Dampers shall have a maximum velocity rating of 3900 fpm.

2.4 CONSTRUCTION

A. Frame: Damper frame shall be 14 ga. aluminum, formed into an 8" x 2" channel.

B. Blades: Damper blades shall be a minimum 0.070 inch thick aluminum strengthened by longitudinal Vee grooves running the entire length of each blade. Blade orientation is horizontal.

C. Blade Stops: Each blade stop (at top and bottom of damper frame) shall occupy no more than ½" of the damper opening area to allow for maximum free area and to minimize pressure loss across the damper.

D. Seals: Blade Edge: TPE.

E. Linkage: External, heavy duty type with steel clevis arms and plated steel tie bars and pivot pins with nylon pivot bearings.

F. Axles: Minimum 3/8" square stainless steel.

G. Bearings: Galvanized steel ball bearing is standard.

H. Finish: Mill

2.5 FACTORY TEST

A. Factory cycle damper assemblies to assure proper operation prior to shipment.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive dampers. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization of dampers. Do not proceed with installation until unsatisfactory conditions are corrected.

B. Caution should be taken to ensure proper clearances for counter weight and blade swings during normal damper operation.

3.2 INSTALLATION

A. Install dampers in accordance with manufacturer's Installation Instructions.

B. Dampers must be accessible to allow inspection, adjustment, and replacement of components. The sheet metal contractor shall furnish any access doors in ductwork or plenums required to provide this access. The general contractor shall furnish any access doors required in walls, ceilings, or other general building construction.

C. Install dampers square and free from racking.

D. The installing contractor shall provide and install bracing for multiple section assemblies to support assembly weight and to hold against system pressure.

E. Do not compress or stretch the damper frame into the duct or opening.

F. Attach multiple damper section assemblies together in accordance with manufacturer's instructions. Install support mullions as reinforcement between assemblies as required.

G. Handle dampers using the frame or sleeve. Do not lift or move dampers using blades, actuator or jackshaft.

3.3 ADJUSTING AND CLEANING

A. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 23 22 35

SECTION 23 22 40
FIRE DAMPERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies fire dampers and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. Dampers shall be UL labeled according to UL Standard 555 "Standard for Fire Dampers".

B. All ductwork mounted devices shall be constructed, certified and installed per the following requirements:

1. AMCA 500 – Test Methods for Louvers, Dampers and Shutters
2. AMCA 500D – Laboratory Methods for Testing Dampers for Ratings
3. AMCA 511 – Certified Ratings Program for Air Control Devices
4. ASHRAE standards for duct construction.
5. ICC – International Code Council
6. NFPA 80 – Fire Doors & Other Opening Protectives
7. NFPA 90A – Installation of Air Conditioning and Ventilating Systems
8. NFPA 101 – Life Safety Code
9. NFPA 105 – Standards for Smoke Door Assemblies and Other Opening Protectives
10. SMACNA – (Fifth Edition) Fire, Smoke, and Radiation Damper Guide for HVAC Systems
11. UL 555 – (Seventh Edition) Standard for Safety; Fire Dampers

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

C. Product Data: For each damper include:

1. UL Ratings for fire resistance, leakage, velocity, differential pressure and elevated temperature.
2. UL Installation instructions.
3. Installation Methods.
4. Indicate materials, construction, dimensions, and installation details.

5. Verify conformance to NFPA, UL, MEA, CSFM and applicable building codes.
6. Include damper pressure drop data for all sizes based on tests and procedures performed in accordance with AMCA 500-D.
7. Preparation instructions and recommendations.
8. Storage and handling requirements.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications

1. Manufacturer shall be International Organization for Standardization (ISO) 9001 accredited.

B. Product Qualifications

1. Damper pressure drop ratings shall be based on tests and procedures performed in accordance with AMCA 500 and certified by AMCA (if applicable).
2. Dampers shall meet requirements for fire dampers in accordance:
   a. NFPA 80, 90A, 92A, 92B, and 101
   b. CSFM – 3235: Fire Damper Listing
   c. Applicable Building Codes
3. Dampers shall be tested, rated, and labeled in accordance with:
   a. UL 555 (Seventh Edition), Listing R5531
4. Dampers shall be factory engineered to withstand the specified seismic loads
   a. Minimum design loads shall be calculated to comply with ASCE-7, or local requirements of Authority Having Jurisdiction.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer, material, and location of installation.

B. Store materials in a dry area indoors, protected from damage and in accordance with manufacturer's instructions.

C. Protect materials and finishes during handling and installation to prevent damage.

1.7 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.8 SOURCE QUALITY CONTROL

A. Factory Tests: factory cycle damper assembly to assure proper operation.

1.9 WARRANTY

A. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide fire dampers as manufactured by one of the following:

1. Greenheck
2. Ruskin
3. American Warming and Ventilating

2.2 FIRE RESISTANCE CAPABILITY

A. Dampers shall have a minimum damper rating of 1-1/2 hours for installation in less than 3 hour fire resistance rated assemblies.

B. Dampers shall have a minimum damper rating of 3 hours for installation in 3 hour or greater fire resistance rated assemblies.

C. Fusible link shall be replaceable, rated at 165°F unless noted otherwise.

2.3 DAMPER CONSTRUCTION

A. Fire dampers shall be curtain-type rated for use in dynamic systems with stainless steel closure spring that shall close against the maximum calculated airflow of that portion of the air duct system in which they are installed.

B. Frame shall be Type A, B, or C (round or oval as required) as indicated on the drawings; minimum 20 gauge galvanized steel, with mitered and interlocking corners. Frames and dampers in wet air exhaust shall be stainless steel.

C. Mounting sleeves shall be factory installed or field installed galvanized steel as detailed on the drawings.

1. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of the wall or floor, and thickness of damper frame meets sleeve requirements.

D. Mounting orientation shall be vertical or horizontal as indicated on the drawings.

E. Blades shall be roll-formed, interlocking, 20 gauge galvanized steel. In place of interlocking blades, provide full length, 20 gauge galvanized steel blade connectors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Inspect areas where dampers are to be received. Notify the Architect/Engineer of conditions that would adversely affect the installation or subsequent utilization of dampers. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install dampers in accordance with manufacturer's UL Installation Instructions, product labeling, and NFPA 90A at locations indicated in the drawings. Any damper installation that is not in accordance with the manufacturer's UL Installation Instructions shall be approved prior to installation.

B. Handle dampers using the frame or sleeve. Do not lift or move dampers using blades, jackshaft or any other accessory supplied on the damper.

C. Install dampers square and free from racking.

D. Do not stretch the damper frame into the duct or opening.

E. All dampers shall be secured and supported per SMACNA requirements.

F. Dampers installation shall not conflict with equipment or piping.

G. The installing contractor shall provide and install bracing for multiple section assemblies to support the assembly weight and to hold against system pressure.

H. Attach multiple damper section assemblies together in accordance with manufacturer's instructions.

I. Dampers shall be accessible to facilitate code-required inspection, adjustment, and like for like replacement of components.

J. Division 23 Contractor shall locate all fire damper positions and dimensions and coordinate access requirements with the General Contractor. The Division 23 Contractor shall install all dampers.

K. Contractor shall coordinate post installation inspection and cycle test of each damper as required by IFC, NFPA, and local codes. Final inspection and test report shall be furnished to building Owner for records.

3.3 CONNECTIONS

A. Furnish dampers with inlet and discharge duct connection flanges of construction appropriate to the pressure classification of the duct system in which the damper is installed.

3.4 DUCT ACCESS DOORS

A. Install duct access doors at all damper locations for fusible link repair.

B. Locate duct access doors for easiest accessibility to dampers.

C. Coordinate locations, and sizes of drywall ceiling access doors and shaft access doors (provided by General Trades) to align with duct access doors.

3.5 DEMONSTRATION

A. Demonstrate to the Owner's Representative the fire damper is accessible, operates properly and fusible link is easily replaced.

END OF SECTION 23 22 40

SECTION 23 23 10
LOUVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies ductwork and air distribution equipment and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. All ductwork shall be constructed and installed per the following requirements:

1. SMACNA "HVAC Duct Construction Standards, Metal and Flexible"

2. ASHRAE standards for duct construction.

B. Equipment, materials and installation shall comply with the Local Mechanical Code and all requirements of the local authorities having jurisdiction.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products as manufactured by one of the following:

1. Airolite

2. American Warming and Ventilating

3. Greenheck

4. Ruskin

5. Tamco

2.2 CONSTRUCTION

A. Provide louvers with frame and sill styles that are compatible with adjacent substrate. Louvers shall be specifically manufactured to fit into construction openings in the adjacent substrate with accurate fit and adequate support for a weatherproof installation.

B. Construct louvers of extruded Aluminum alloy frame and blades with all welded construction.

2.3 FINISH

A. Louvers shall be provided with a Kynar finish.

B. Color of louvers will be selected by the Architect. Submit manufacturers standard color charts for selection.

2.4 ACCESSORIES

A. Provide louvers with aluminum bird screens.

PART 3 - EXECUTION

3.1 GENERAL

A. Louver installation shall not conflict with equipment or piping.

B. Louvers shall be securely anchored in place, as recommended by the manufacturer's installation instructions.

C. Install louvers in locations as indicated on the drawings and in accordance with the manufacturer's installation instructions.

D. Mechanical Contractor shall locate all louver positions and dimensions and coordinate requirements with the General Contractor. The Mechanical Contractor shall install louvers.

3.2 ADJUSTING AND CLEANING

A. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 23 23 10

SECTION 23 30 10
EQUIPMENT IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies mechanical system equipment identification and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

PART 2 - PRODUCTS

2.1 EQUIPMENT NAMEPLATES

A. Nameplates shall be laminated phenolic with black surface and white core. Use 1/16" thick material for plates up to 2" by 4". For larger sizes use 1/8" thick. Letters and numbers shall be a minimum of ½" high.

2.2 CEILING MARKERS

A. Ceiling markers shall be provided for mechanical devices concealed above ceilings, including all terminal boxes, all fire dampers and all smoke dampers.

B. Ceiling markers shall be 1" diameter white sticky tags with ¼" black lettering.

C. Markers for terminal boxes shall match the Controls address.

D. Markers for the dampers shall follow the facility's numbering designation.

E. Ceiling markers shall be worded as follows:

1. Terminal boxes – TB-xxx where "TB" is the abbreviation for terminal box, and xxx is the BAS controls address of the terminal box.

2. Fire dampers (FD), Smoke dampers (SD) and combination fire/smoke dampers (FSD) – FD-xxx where xxx is the Owner's designated damper number.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in mechanical identification work with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated in coordination with the Owner or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.

3.3 EQUIPMENT IDENTIFICATION

A. Provide nameplates to identify all specified equipment with letters and numbers matching equipment designation as indicated on the drawings.

B. Nameplates shall be fastened by use of stainless steel sheet metal screws.

C. Where equipment does not have a location for mounting of a nameplate, provide a stencil identification.

D. Stencils shall be made with a color which stands out against the equipment finish color. Stencils shall be a minimum of 2" high.

E. Apply one coat of lacquer or varnish over the stencils for protection.

F. Nameplates and stencils shall be applied after any field painting of equipment.

G. Install labels on ceiling grid at VAV locations, duct smoke detectors, differential pressure sensors and static pressure sensors. Ceiling tag shall indicate VAV terminal designation along with thermostat BAS tag.

H. All expansion tanks, relief valves and pressure reducing valves shall have system set pressure attached to device once final set point is complete.

I. General: Install engraved plastic equipment marker on or near each major item of mechanical equipment and each operational device. Provide signs for the following general categories of equipment and operational devices:

1. Air Handling Units
2. Boilers
3. Chillers
4. Compressors
5. Condensing Units
6. Control devices including control valves, differential pressure sensors and transmitters, etc.
7. Cooling Towers
8. Exhaust Fans
9. Fans
10. Fluid Coolers
11. Furnaces
12. Heat Exchangers
13. Heaters
14. Humidifiers
15. Pumps
16. Reduced pressure backflow preventer
17. Tanks
18. Variable Frequency Drives
19. Water Treatment Systems

3.4 CEILING MARKERS INSTALLATION

A. Ceiling markers shall be located in close proximity to the device it tags. Ceiling markers shall be installed on the tee bars of layin ceilings, but not on the main runs.

END OF SECTION 23 30 10

SECTION 23 30 20
EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies equipment insulation materials and installation methods common to more than one section of Division 23.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all insulation work described in this Section.

1.3 CODES AND STANDARDS

A. Provide all insulation materials (insulation, jackets, fitting covers, adhesives, cements, mastics, sealers and finishes) with a flame-spread index of 25 or less and smoke developed index of 50 or less, as tested under procedure ASTM E-84 (NFPA 255).

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Sections 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Unless otherwise noted, and subject to compliance with Specifications, provide insulation materials from the manufacturers specified below:

1. Closed Cell Elastomeric Insulation
    a. Insul-Tube
    b. K-Flex USA
    c. Manson Insulation
    d. Nomaco Kflex
    e. Techlite Insulation
    f. Thermacel
2. Fiberglass Blanket Insulation
    a. Certain Teed
    b. Johns Manville
    c. Knauf Insulation
    d. Owens Corning
3. Removable Thermal Blanket (Jacket) Insulation

a. Advance Thermal Corp.

b. Firwin Corporation.

c. Shannon Enterprises of W.N.Y. Inc.

d. Thermaxx, LLC.

2.2 FIBERGLASS EQUIPMENT INSULATION

A. Fiberglass insulation shall have a minimum density of 2.8 lbs per cubic foot.

B. Fiberglass insulation shall have an all service jacket.

C. Provide fiberglass insulation for the following equipment:

Table 23 30 20.1

Equipment Type	Insulation Thickness (Sheet)
Heating Water Pump Bodies	1”
Heating Water Air Separators, Expansion Tanks and Suction Diffusers	1”
Hot Water Tanks	2”

2.3 REMOVABLE THERMAL BLANKET (JACKET) INSULATION

A. Provide a removable thermal blanket (jacket) insulation assembly for all equipment indicated on drawings or in other sections of this Specification.

B. Operating Temperature: Maximum service temperature shall be no less than 450°F.

C. Blanket Components: Inner and outer jacket shall be constructed of 17 oz/sq. yd. silicone impregnated fiberglass cloth.

D. Blanket Construction: The blanket shall be a double sewn lock stitch. No raw cut edges shall be permitted. Stitching shall be done with Teflon ® coated fiberglass of Teflon® coated Nomex®.

E. Identification: All blankets shall be provided with an aluminum name plate riveted to each blanket piece. Lettering shall be 1/8” embossed to show location, description, size, pressure rating, and tag identification.

F. Provide thermal blanket insulation for the following equipment:

Table 23 30 20.2

Equipment Type	Insulation Thickness (Sheet)
Heating Water System Strainers	1”

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Install insulation products according to manufacturer's printed instructions, in compliance with recognized industry standards and this specification.

B. Install all insulation over clean dry surfaces. Insulation must be dry and in good condition. Wet or damaged insulation is not acceptable.

C. Install all insulation only after the completion of system pressure tests, leakage tests and installation of heat trace.

D. Install insulation materials with smooth even surfaces. Use full lengths of insulation where possible, only cut where necessary. Do not use cut pieces or scraps abutting each other.

E. Repair existing equipment insulation where removed to make new connections, to add temperature controls, or where damaged by new construction. Use same insulation as specified for new service.

F. Where existing asbestos insulation is discovered or suspected notify the building Owner immediately so it can be removed under a separate "Asbestos Removal Contract".

G. Install insulation materials with smooth and even surfaces. Rework all poorly fitted joints. Do not use joint sealer or mastic as filler for joint gaps and excessive voids resulting from poor workmanship. Apply using staggered joint method for multi-layer installations, applying each layer of insulation separately.

H. Coat insulated surfaces without vapor barrier with a layer of insulating cement, troweled to a smooth and continuous surface. Fill in seams, broken edges, and depressions. Cover over wire mesh and joints with cement sufficiently thick to remove surface irregularities.

I. Maintain the integrity of factory-applied vapor barrier jacketing on all insulation, protecting it against puncture, tears or other damage.

J. For field-applied all-service vapor barrier jacketing, neatly fit and tightly secure. Lap seams 2 inches minimum. Seal all joints with adhesive. Tape with 3 inch matching pressure-sensitive tape or 3 inch glass fabric and mastic.

K. Removable insulation: Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance as scheduled and as required for inspection such as vessel covers, fasteners, flanges, frames, etc.

L. On hot equipment, do not insulate handholes, clean-outs, ASME stamps and manufacturers nameplates. Bevel and seal insulation edges at these locations. On cold equipment (to prevent condensation), provide removable insulation sections over these locations. Tag surfaces to indicate what is concealed.

M. Miter rigid fiberglass equipment insulation to fit shape of equipment and secure in place with steel bands at 12 to 18 inches on center. Seal all joints with matching pressure sensitive joint sealing tape.

3.2 PROTECTION

A. Replace damaged insulation which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.

B. The insulation installer shall advise the General and the Mechanical Contractors as to requirements for protection of the insulation work during the remainder of the construction period (after the installation of insulation), to avoid damage and deterioration of the finished insulation work.

END OF SECTION 23 30 20

SECTION 23 33 52
GAS-FIRED STAINLESS STEEL CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

B. Extent of boiler work required by this Section indicated on drawings and schedules and by requirements of this Section.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of pulse combustion boilers, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: The HVAC Contractor shall be registered with the State of Ohio, Division of Boiler Inspection. Contractor shall obtain an installation permit from the State of Ohio, Division of Boiler Inspection, prior to beginning work. Boilers' installation shall be in full compliance with all requirements of OBC Boiler Code.

C. Codes and Standards:

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

2. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code: Section IV.

3. NFPA Compliance: Install gas-fired boilers in accordance with NFPA Code 54 "National Fuel Gas Code."

4. I=B=R Performance Compliance: Condensing boilers must be rated in accordance with applicable federal testing methods and verified by AHRI as capable of achieving the energy efficiency and performance ratings as tested within prescribed tolerances.

5. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

6. DOE Compliance. Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."

7. UL Compliance. Boilers must be tested for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

8. NOx Emission Standards. When installed and operated in accordance with manufacturer's instructions, condensing boilers shall comply with the NOx emission standards outlined in South Coast Air Quality Management District (SCAQMD), Rule 1146.2; and the Texas Commission on Environmental Quality (TCEQ), Title 30, Chapter 117, Rule 117.465.

D. SOURCE QUALITY CONTROL

1. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code: Section IV, for low-pressure boilers.

2. Each boiler shall be factory fire tested with a combustion report supplied with the boiler or affixed to the boiler cabinet.

1.4 DELIVERY, STORAGE AND HANDLING

A. Handle boilers and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged boilers or components; replace with new.

B. Store boilers and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

C. Comply with manufacturer's rigging and moving instructions for unloading boilers and moving them to final location.

1.5 SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

1. Prior to combustion air duct and flue vent installation, engineered calculations and drawings must be submitted to Engineer to thoroughly demonstrate that size and configuration conform to size, length and footprint for each submitted boiler as shown on the Contract documents.

2. Efficiency Curves: At a minimum, submit efficiency curves for 100%, 50%, and 20% input firing rates at incoming water temperatures 100°F, 120°F, 140°F and 160°F.

3. Pressure Drop Curve: Submit pressure drop curve for flows ranging from 0 GPM to design value of boiler.

B. Shop Drawings: Provide shop drawings for boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work. Detail power, signal, and control wiring.

C. Submit Startup service report. Include report with operation and maintenance manuals.

D. Provide Operation and Maintenance Data for boilers in operation and maintenance manuals.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base.

1.7 SPECIAL WARRANTY PERIOD FOR FIRE-TUBE CONDENSING BOILERS

A. The pressure vessel/heat exchanger shall carry a 10-year from shipment, prorated, limited warranty against any failure due to condensate corrosion, thermal stress, mechanical defects or workmanship.

B. Manufacturer labeled control panels are conditionally warranted against failure for (2) two years from shipment.

C. All other components, with the exception of the igniter and flame detector, shall be guaranteed against any failure for 18 months from shipment

1.8 EXTRA MATERIALS

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

1. The Mechanical Contractor shall provide a maintenance kit that the boiler manufacturer recommends for its first service.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide high efficiency-condensing boilers as manufactured by one of the following:

1. Aerco International (Benchmark)
2. Lochinvar
3. Bosch Thermal Technology
4. Cleaver Brooks

2.2 GENERAL

A. Boilers shall be natural gas fired, fully condensing, fire tube design.

B. Power burner shall have full modulation, and discharge into a positive pressure vent.

C. Boiler efficiency shall increase with decreasing load (output), while maintaining setpoint. Boilers shall be factory-fabricated, factory-assembled and factory-tested, fire-tube condensing boilers with heat exchanger sealed pressure-tight, built on a steel base, including insulated jacket, flue-gas vent, combustion-air intake connections, water supply, return and condensate drain connections, and controls.

2.3 HEAT EXCHANGER

A. The heat exchanger shall be constructed of 439 stainless steel fire tubes and tubesheets, with a one-pass combustion gas flow design.

B. The fire tubes shall be 5/8" OD, with minimum 0.049" wall thickness.

C. The upper and lower stainless steel tubesheet shall be minimum 0.25" thick.

D. The pressure vessel/heat exchanger shall be welded construction. The heat exchanger shall be ASME stamped for a working pressure not less than 160 psig.

E. Access to the tubesheets and heat exchanger shall be available by burner and exhaust manifold removal. Minimum access opening shall be no less than 8-inch diameter.

2.4 PRESSURE VESSEL

A. The boiler water connections shall be flanged, 150-pound, ANSI rated.

B. The pressure vessel shall be constructed of SA53 carbon steel, with a 0.25-inch thick wall and 0.50-inch thick upper head.

C. Inspection openings in the pressure vessel shall be in accordance with ASME Section IV pressure vessel code.

D. The boiler shall be designed so that the thermal efficiency increases as the boiler firing rate decreases.

2.5 MODULATING AIR/FUEL VALVE AND BURNER

A. The boiler burner shall be capable of a 20-to-1 turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves.

B. The burner shall produce less than 16 ppm of NOx corrected to 3% excess oxygen.

C. The unit shall be certified by the South Coast Air Quality Management District (SCAQMD) as compliant with Rule 1146.2 for boilers and water heaters less than or equal to 2 MBTUs, and the Texas Commission on Environmental Quality (TCEQ) as being compliant with Section 117.465 for boilers less than or equal to 2 MBTUs.

D. The burner shall be metal-fiber mesh covering a stainless steel body with spark ignition and flame rectification.

E. All burner material exposed to the combustion zone shall be of stainless steel construction.

F. There shall be no moving parts within the burner itself.

G. A modulating air/fuel valve shall meter the air and fuel input.

H. The modulating motor must be linked to both the gas valve body and air valve body with a single linkage.

I. The linkage shall not require any field adjustment.

J. A variable frequency drive (VFD), controlled cast aluminum pre-mix blower shall be used to ensure the optimum mixing of air and fuel between the air/fuel valve and the burner.

K. Minimum boiler efficiencies shall be as follows at a 20 degree delta-T:

EWT	100% Fire	50% Fire	5% Fire
160 °F	86%	86.6%	88%
120 °F	88.5%	89.1%	90.9%
60 °F	95.5%	97.5%	99.3%

L. The exhaust manifold shall be of corrosion resistant cast aluminum with a 6-inch diameter flue connection. The exhaust manifold shall have a collecting reservoir and a gravity drain for the elimination of condensation.

2.6 BLOWER

A. The boiler shall include a variable-speed, DC centrifugal fan to operate during the burner firing sequence and pre-purge the combustion chamber.

1. Motors: Blower motors shall comply with requirements specified in other Division 23 Sections.

a. Motor Sizes: Provide minimum size as indicated. If not indicated, large enough so driven load will not require a motor to operate in the service factor range above 1.0.

2.7 IGINTION

A. Ignition shall be via spark ignition with 100 percent main-valve shutoff and electronic flame supervision.

2.8 CONTROLS

A. Each boiler control panel shall consist of six individual circuit boards using state-of-the-art surface-mount technology in a single enclosure. These circuit boards shall include:

1. A display board incorporating LED display to indicate temperature and a vacuum fluorescent display module for all message enunciation

2. A CPU board housing all control functions

3. An electric low-water cutoff board with test and manual reset functions

4. A power supply board

5. An ignition /stepper board incorporating flame safeguard control

6. A connector board

7. Each board shall be individually field replaceable.

B. The combustion safeguard/flame monitoring system shall use spark ignition and a rectification-type flame sensor.

C. The control panel hardware shall support both RS-232 and RS-485 remote communications.

D. The controls shall annunciate boiler and sensor status and include extensive self-diagnostic capabilities that incorporate a minimum of eight separate status messages and 34 separate fault messages.

E. The control panel shall incorporate three self-governing features designed to enhance operation in modes where it receives an external control signal by eliminating nuisance faults due to over-temperature, improper external signal or loss of external signal. These features include:

1. Setpoint High Limit: Setpoint high limit allows for a selectable maximum boiler outlet temperature and acts as temperature limiting governor. Setpoint limit is based on a PID function that automatically limits firing rate to maintain outlet temperature within a 0 to 10 degree selectable band from the desired maximum boiler outlet temperature.

2. Setpoint Low Limit: Setpoint low limit allows for a selectable minimum operating temperature.

3. Failsafe Mode: Failsafe mode allows the boiler to switch its mode to operate from an internal setpoint if its external control signal is lost, rather than shut off. This is a selectable mode, enabling the control can to shut off the unit upon loss of external signal, if so desired.

F. The boiler control system shall incorporate the following additional features for enhanced external system interface:

1. System start temperature feature

2. Pump delay timer

3. Auxiliary start delay timer

4. Auxiliary temperature sensor

5. Analog output feature to enable simple monitoring of temperature setpoint, outlet temperature or fire rate

6. Remote interlock circuit

7. Delayed interlock circuit

8. Fault relay for remote fault alarm

G. Each boiler shall include an electric, single-seated combination safety shutoff valve/regulator with proof of closure switch in its gas train. Each boiler shall incorporate dual over-temperature protection with manual reset, in accordance with ASME Section IV and CSD-1.

H. Each Boiler control panel shall utilize the BACNET protocol to communicate with the Building Automation System (BAS) via the RS-485 port.

I. The BAS controller shall have the ability to vary the firing rate and energy input of each individual boiler throughout its full modulating range to maximize the condensing capability and thermal efficiency output of the entire heating plant. The BAS controller shall control the boiler outlet header temperature within +2°F. The BAS controller shall provide contact closure for auxiliary equipment such as each boiler's isolation valve and combustion air inlet dampers based upon outdoor air temperature.

J. The BAS controller shall have the following anti-cycling features:

1. Manual designation of lead boiler and last boiler.

2. Lead boiler rotation at user-specified time interval.

3. Delay the firing/shutting down of boilers when header temperature is within a predefined deadband.

K. When set on Internal Setpoint Mode, temperature control setpoint on the Boiler control panel shall be fully field adjustable from 50ºF to 190ºF in operation.

L. When set on Automatic Control Mode, the BAS controller will operate the plant to vary header temperature setpoint as an external communication utilizing the hardwired connections and BACNET protocol is supplied via the RS-232 port.

2.9 ELECTRICAL POWER

A. Controllers, Electrical Devices and Wiring: Electrical devices and connections are specified in Division 26 sections.

B. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers and other electrical devices shall provide a single-point field power connection to the boiler.

C. Electrical Characteristics:

1. Voltage: 120 V
2. Phase: Single
3. Frequency: 60 Hz
4. Full-Load Current 13 Amps

2.10 VENTING

A. The exhaust vent shall be UL Listed for use with Category III and IV appliances and compatible with operating temperatures up to 480°F, positive pressure, condensing flue gas service. UL-listed vents of Al 29-4C stainless steel must be used with boilers.

B. The minimum exhaust vent duct size for each boiler is six-inch diameter.

C. Combustion-Air Intake: Boilers shall be capable of drawing combustion air from the outdoors via a metal duct connected between the boiler and the outdoors.

D. The minimum sealed combustion air duct size for each boiler is six-inch diameter.

E. Common Vent and Common Combustion Air must be an available option for boiler installation. See Requirements under Part 1 – "Submittals" for common vent and combustion air sizing.

F. Follow guidelines specified in manufacturer's venting guide.

2.11 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions and carbon monoxide in flue gas, and to achieve combustion efficiency. Perform hydrostatic testing.

B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

2.12 CONDENSATE NEUTRALIZERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide high efficiency-condensing boiler condensate neutralizers as manufactured by one of the following (or approved substitution):

1. BKI Industries
2. CON-DOR

3. JJM Boiler Works

B. The contractor shall supply and install fireside condensate neutralizing tubes for each boiler condensate drain and all flue pipe condensate drains.

C. The condensate tubes shall be designed to raise the PH level 10–1,000 times more towards the neutral point of the PH being discharged by the boiler.

D. The contractor shall supply all boilers and vent condensate drains with "P-traps" and unions before the neutralizing tubes.

E. All piping shall be CPVC and supplied/installed by the contractor. Plastic tubing is an acceptable alternative when used with barbed fittings and hose clamps. All CPVC joints shall be glued in place and all barbed fittings shall be secured with tie wraps.

F. All neutralizing tubes shall be secured to the floor or wall so as not to be exposed to damage or within a normal walkway. The contactor shall fill all "P-traps" and neutralizing tubes with tap water before the firing of any boiler.

G. The contractor shall inform the owner of any maintenance or scheduled recharge of the tube's limestone aggregate as described in the manufacturer's I & O manual.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before boiler installation, examine roughing 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.

B. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

C. Examine mechanical space for suitable conditions where boilers will be installed. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Contractor is responsible to verify boiler access during bidding under the specified standard boiler or any accepted substitution boiler.

3.2 INSTALLATION

A. Install boilers in accordance with manufacturer's published installation instructions, in accordance with State and local code requirements, and in accordance with requirements of local Utility Company.

B. Install boilers level on concrete base. Install units plumb and level to tolerance of 1/8" in 10'-0" in both directions. Maintain manufacturer's recommended clearances around and over boilers.

C. Install boilers in accordance with NFPA 54.

D. Assemble and install boiler trim.

E. Install electrical devices furnished with boiler but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect gas piping full size to boiler gas-train inlet with union, full port shut off ball valve and dirt leg.

C. Connect hot-water piping to supply and return boiler tappings with shutoff valve and union or flange at each connection.

D. Install piping from safety relief valve(s) down to 6" above floor.

E. Connect combustion air duct and flue vent full size to boiler inlet and outlet.

F. Install piping adjacent to boiler to allow service and maintenance.

G. Ground equipment and connect wiring according to Division 26 requirements.

H. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening valves. If manufacturer's torque valves are not indicated, use those specified in UL 486A and UL 486B.

I. Provide P-Trap at bottom of flue vent riser and at all low spots and extend condensate piping to neutralizers.

3.4 STARTUP SERVICE

A. Contractor shall provide the services of a local factory authorized representative to supervise all phases of boiler equipment startup. A letter of compliance with all factory recommendations and installation instructions shall be submitted to the engineer and included with operation and maintenance instructions.

B. Perform installation and startup checks according to manufacturer's written instructions.

C. Perform a leak hydrostatic leak test. Repair leaks and retest until no leaks exist.

D. Adjust air-fuel ratio and combustion.

E. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

F. Adjust initial temperature set points.

G. Set field-adjustable switches and circuit-breaker trip ranges.

H. Submit a written report that documents testing procedures and results.

3.5 DEMONSTRATION AND TRAINING

A. Owner's Instructions: Provide services of manufacturer's technical representative for two separate 4-hour days to instruct Owner's personnel in operation and maintenance of boilers.

B. Schedule training with Owner, provide at least 7-day notice to Contractor and Engineer of training date.

END OF SECTION 23 33 52

SECTION 23 34 10
END SUCTION PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. Extent of end suction pump work required by this Section is indicated on drawings and schedules, and by requirements of this Section.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings for each end suction pump, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

C. Start-up Report:

1. rovide completed start-up form, per the requirements of Section 23 03 20.

D. Furnish submittals are required per section 2301 10 “Project Submittal Requirements”

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

B. HI Compliance: Design, manufacture, and install HVAC pumps in accordance with HI - "Hydraulic Institute Standards."

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

D. UL Compliance: Comply with UL 778 for motor-operated water pumps.

E. UL and NEMA Compliance: Provide electric motors and components which are listed and labeled by Underwriters Laboratories and comply with NEMA standards.

F. Comply with AWWA specifications for Lineshaft Turbine Pumps.

G. Design Criteria: The Drawings indicate sizes, profiles, connections, and dimensional requirements of plumbing pumps, and are based on the specific manufacturer types and models indicated. Pumps having equal performance characteristics by other named manufacturers may be considered, provided deviations in dimensions and profiles and efficiencies do not change the design concept or intended performance as judged by the Engineer.

H. For variable speed pumps, pump impeller size shall be maximized for scheduled horsepower. Pump shall be non-overloading for scheduled horsepower.

I. For constant speed pumps, impellers shall be sized for a maximum diameter not to exceed 85% of the selected pump’s largest diameter.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.6 COORDINATION

A. Coordinate size and location of sumps with the General Contractor.

1.7 EXTRA MATERIALS

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

1. Mechanical Seals: Provide two mechanical seals for each pump.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide separately coupled, base-mounted, end-suction centrifugal pumps as manufactured by one of the following:

1. Armstrong Pumps Inc.
2. Bell & Gossett; Div. of ITT Industries.
3. PACO Pumps.
4. Taco, Inc.
5. Patterson Pumps
6. Weinman; Div. of Crane Pumps & Systems.

2.2 GENERAL

A. Factory assembled and tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

B. Rate pump for 125-psig minimum working pressure and a continuous water temperature of 250 °F per ANSI B16.1 Class 125.

2.3 CASING

A. Radially split, cast iron, with replaceable bronze wear rings, threaded gage tapings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections.

B. Provide integral mount on volute to support the casing, and attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.

C. Pump casing/volute shall be tested for 175 psi working pressure per ANSI B16.1 Class 125.

D. Pump volute shall be foot mounted/overhung cantilevered designs are not allowable.

E. Pump casing shall be drilled and tapped for gauge pressure ports on both the suction and discharge connections. Provide additional tapping on discharge connection to allow for installation of a seal flush line.

2.4 IMPELLER

A. ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.

2.5 PUMP SHAFT

A. Steel with bronze sleeve or stainless steel.

2.6 MECHANICAL SEAL

A. Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket.

2.7 PUMP BEARINGS

A. Grease-lubricated ball bearings replaceable without distributing the piping connections.

2.8 SHAFT COUPLING

A. Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor. Provide coupling compatible with variable-speed applications.

2.9 COUPLING GUARD

A. Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

2.10 MOUNTING FRAME

A. Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

B. The base shall be provided with an integral frame pan fabricated from steel with a minimum thickness of 0.1875" and shall contain an integral 3/4" drain connection.

2.11 MOTOR

A. Motors shall meet scheduled horsepower, speed, voltage, and enclosure design.

B. Motor selection shall be non overloading at any one point on the pump curve and shall meet NEMA specifications for premium efficiency.

C. Motor shall be inverter rated with class F insulation, for use with a variable frequency drive.

2.12 OPTIONS AND ACCESSORIES

A. Furnish each pump with options and accessories as indicated on the schedule on the drawings.

1. Coupling Guard
2. Suction Diffuser
3. Inertia Base
4. Spring Vibration Isolators

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

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

3.2 CONCRETE BASES

A. Install concrete bases of dimensions indicated for pumps and controllers.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.

2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.3 INSTALLATION

A. Comply with HI 1.4 HI 2.4. As applicable.

B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Suspend vertically mounted, in-line centrifugal pumps independent of piping. Install pumps with motor and pump shafts vertical. Use continuous-thread hanger rods and elastomeric hangers of sufficient size to support pump weight.

E. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.

1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.

2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

3.4 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.

B. Comply with pump and coupling manufacturers' written instructions.

C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation and HI 2.1-2.5, "Vertical Pumps for Nomenclature, Definitions, Application and Operation."

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.5 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install check valve, spool piece, and shutoff throttling valve on discharge side of pumps.

F. Install suction diffuser venturi fitting, reducing elbow (where applicable), Y-strainer, and shutoff valve on suction side of pumps.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.

I. Install check valve and gate or ball valve on each condensate pump unit discharge.

J. Install electrical connections for power, controls, and devices.

K. Ground equipment according to Division 26 requirements.

L. Connect wiring according to Division 26 requirements.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

2. Check piping connections for tightness.

3. Clean strainers on suction piping.

4. Perform the following startup checks for each pump before starting:

a. Verify bearing lubrication.

b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.

c. Verify that pump is rotating in the correct direction.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.

6. Start motor.

7. Open discharge valve slowly.

3.7 DEMONSTRATION

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

END OF SECTION 23 34 10

SECTION 23 50 11
CENTRIFUGAL ROOF EXHAUST FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies down-blast centrifugal roof fans and air distribution equipment and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

C. Extent of work required for fans is indicated by drawings and schedules and as specified herein.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of fans, of types, ratings and capacities required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 CODES AND STANDARDS

A. AMCA Compliance: Provide fans which have been tested and rated in accordance with AMCA standards and bear AMCA Certified Rating Seal.

B. UL Compliance: Provide fans which are listed by UL and have UL label affixed.

C. UL Compliance: Provide fans which are designed, manufactured and tested in accordance with UL 705 "Power Ventilators".

D. NEMA Compliance: Provide motors and electrical accessories complying with NEMA standards.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

C. Start-up Report:

1. Provide completed start-up form, per the requirements of Section 23 03 20.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver fans in factory-fabricated crates, containers or wrappings which properly protect fans from damage.

B. Store fans in original packaging and protect from weather and construction traffic. Wherever possible, store in doors. Where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle fans carefully to prevent damage, breaking, denting and scoring of finishes. Do not install damaged units or components; replace with new.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide down-blast centrifugal roof fans as manufactured by one of the following:

1. Greenheck Fan Corp.
2. Cook (Loren) Co.
3. New York Blower Company
4. Twin City

2.2 GENERAL

A. Provide belt-driven, spun aluminum, down-blast fans of the sizes and capacities as scheduled and herein specified consisting of fan blades, hub, housing, motor, drive, roof curb and accessories.

2.3 FAN WHEEL

A. The fan wheel shall be centrifugal non-overloading backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced in accordance to AMCA Standard 204-05.

2.4 FAN HOUSING

A. The fan housing shall consist of the motor cover, shroud, curb cap and lower windband and shall be constructed of heavy gauge aluminum. Housing shall have a rigid internal support structure and leak proof design. The fan shroud shall be one piece with a rolled bead for extra strength which directs exhaust air downward. The lower windband shall be one piece with formed edges for added strength and the curb cap shall include prepunched mounting holes to ensure correct attachment to the roof.

2.5 FAN SHAFTS

A. Fan shafts shall be precision ground and polished solid steel with an anti-corrosive coating. Fan shafts shall be mounted in permanently sealed lubricated pillow bock ball bearings. The first critical speed on a fan shaft shall be at least 25 percent over maximum operating speed. Bearings shall be selected for a minimum (L10) life in excess of 100,000 hours at a maximum cataloged operating speed. All bearings shall be 100 percent factory tested.

2.6 DRIVE FRAME

A. Belt Drive

1. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.
2. Pulleys shall be of the fully machined cast iron type, keyed and security attached to the wheel and motor shafts.
3. Motor pulleys shall be fixed pitch type.

2.7 MOTORS

A. Belt-Drive:

1. Motors shall be heavy duty ball bearing type, carefully matched to the fan load, and furnished at the specific voltage, phase and enclosure.
2. Drives shall be sized for a minimum of 150 percent of driven horsepower.

3. Motors and drives shall be mounted on vibration isolators, out of the airstream.
4. Fresh air for motor cooling shall be drawn into the motor compartment from an area free of discharge contaminants.
5. Motors shall be readily accessible for maintenance.
6. Vibration isolators shall be double studded or pedestal mount with no metal to metal contact. Each vibration isolator shall be sized to match the weight of each fan.

B. Direct Drive

1. Motors shall be a DC electronic commutation type motor (ECM) specifically designed for fan applications.
2. ECM motors shall have open type enclosures.
3. Motors shall be permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
4. Furnish with all necessary internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor.
5. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.
6. Motor shall be minimum 85% efficient at all speeds.
7. AC induction type motors are not acceptable for direct drive fan applications.

2.8 DISCONNECT

A. A disconnect switch shall be wired from the fan motor to a junction box installed within the motor compartment.

B. Disconnect switch shall be factory mounted.

2.9 OPTIONS AND ACCESSORIES

A. Furnish each fan with options and accessories as indicated on the schedule on the drawings.

1. Auto belt tensioner
2. Bird screen
3. Curb extension
4. Curb seal
5. Hinge kit with base
6. Roof curb and tie down points

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which fans are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected

3.2 INSTALLATION

A. General: Except as otherwise indicated or specified, install fans in accordance with manufacturer's installation instructions and recognize industry practices to insure that fans serve their intended function

B. Coordinate fans and accessories with roofing work, as necessary for proper interfacing.

C. Remove shipping bolts, blocks and temporary supports within fans. Adjust dampers for free operation.

D. Provide roof curbs to the General Contractor at the job site. Roof curbs shall be installed by and incorporated into the roofing system by the General Contractor.

3.3 ELECTRICAL WIRING

A. Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer wiring diagram submittal to Electrical Installer.

B. Verify that motors and electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 Sections. Verify proper rotation directions of fan wheels. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

3.4 FIELD QUALITY CONTROL

A. Testing: After installation of fans has been completed, test each fan to demonstrate proper operation of units at performance requirements specified. When possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected.

3.5 ADJUSTING AND CLEANING

A. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 23 50 11

SECTION 23 50 13
IN-LINE CENTRIFUGAL FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies in-line centrifugal fans and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

C. Extent of work required for fans is indicated by drawings and schedules and as specified herein.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of fans, of types, ratings and capacities required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 CODES AND STANDARDS

A. AMCA Compliance: Provide fans which have been tested and rated in accordance with AMCA standards and bear AMCA Certified Rating Seal for both air and sound performance.

B. UL Compliance: Provide fans which are listed by UL and have UL label affixed.

C. UL Compliance: Provide fans which are designed, manufactured and tested in accordance with UL 705 "Power Ventilators".

D. NEMA Compliance: Provide motors and electrical accessories complying with NEMA standards.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver fans in factory-fabricated crates, containers or wrappings which properly protect fans from damage.

B. Store fans in original packaging and protect from weather and construction traffic. Wherever possible, store in doors. Where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle fans carefully to prevent damage, breaking, denting and scoring of finishes. Do not install damaged units or components; replace with new.

1.6 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

C. Start-up Report:

1. Provide completed start-up form, per the requirements of Section 23 03 20.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Subject to compliance with requirements, provide in-line centrifugal cabinet fans as manufactured by one of the following:

1. Cook (Loren) Co.
2. Greenheck Fan Corp.
3. New York Blower Company
4. Twin City

2.2 GENERAL

A. Provide direct- or belt-driven in-line centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.

2.3 FAN HOUSING

A. The fan housing shall be of the rectangular design constructed of rigid structural members and formed galvanized steel panels with acoustical fiberglass lining.

B. The side of the fan housing shall be equipped with a hinged or removable panel of sufficient size to permit access for serving to all of the fan's internal components without dismantling the cabinet.

C. Provide rectangular duct mounting collars on inlet and discharge side of fan.

2.4 FAN WHEEL

A. The fan wheel shall be constructed of aluminum steel and shall be backward inclined, centrifugal type.

B. Fan wheel assembly shall be both dynamically and statically balanced.

2.5 FAN SHAFT

A. The fan shaft shall be ground and polished steel mounted in permanently sealed pillow block bearings having a minimum average bearing life (L50) of over 200,000 hours at maximum cataloged operating speed.

B. For belt-driven fans, constant pitch cast iron pulleys shall be keyed to fan and motor shafts. Belts shall be sized for 150% of driven horsepower.

2.6 MOTOR

A. For belt-driven fans, the motor shall be mounted on the outside of the housing, out of the airstream as indicated. The motor shall be as specified in other Division 23 Sections. See drawings for motor position. Motor base shall have two adjustment bolts for belt tightening and adjustment.

B. For direct-drive fans, motors shall be ECM DC brushless style complete with operated by a single phase integrated controller/inverter that operates the wound stator and sensor motor position to electronically commutate the stator. All motors shall be designed for synchronous rotation. Motor shall permanently lubricated with ball bearings. Motor shall maintain a minimum of 70% EFFICIENCY OVER ITS ENTIRE OPERATING RANGE. Motors shall be direct coupled to the blower. Provide isolation between motor and blower assembly. Provide manual fan speed control for field adjustment of fan air flow set-point.

2.7 WIRING

A. Flexible wiring leads shall be provided from the motor to an externally side-mounted junction box, for field mounting disconnect switch allowing access for service without disconnecting field wiring.

2.8 ACCESSORIES

A. Provide each fan with the following options:

1. Four (4) mounting brackets for horizontal ceiling suspension or vertical mounting (see drawings).

2. Disconnect Switch: Where indicated, provide a non-fusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

3. Spring-type support isolators.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which fans are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Except as otherwise indicated or specified, install fans in accordance with manufacturer's installation instructions and recognize industry practices to insure that ventilators serve their intended function.

B. Coordinate fans and accessories with work of walls and ceilings, as necessary for proper interfacing.

C. Install ceiling suspended fans from overhead structure utilizing spring type isolators furnished by the fan manufacturer.

3.3 ELECTRICAL WIRING

A. Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer wiring diagram submittal to Electrical Installer.

B. Verify that motors and electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 Sections. Verify proper rotation directions of fan wheels. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

C. Remove shipping bolts, blocks and temporary supports within fans. Adjust dampers for free operation.

3.4 FIELD QUALITY CONTROL

A. Testing: After installation of fans has been completed, test each fan to demonstrate proper operation of units at performance requirements specified. When possible, field correct malfunctioning units, and then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected.

3.5 ADJUSTING AND CLEANING

A. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 23 50 13

SECTION 23 50 18
CEILING TOILET EXHAUST FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies centrifugal ceiling fans with inlet grilles and in-line ducted fans above ceilings and air distribution equipment and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

C. Extent of work required for fans is indicated by drawings and schedules and as specified herein.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of fans, of types, ratings and capacities required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 CODES AND STANDARDS

A. AMCA Compliance: Provide fans which have been tested and rated in accordance with AMCA standards and bear AMCA Certified Rating Seal.

B. UL Compliance: Provide fans which are listed by UL and have UL label affixed.

C. UL Compliance: Provide fans which are designed, manufactured and tested in accordance with UL 705 "Power Ventilators".

D. NEMA Compliance: Provide motors and electrical accessories complying with NEMA standards.

1.5 SUBMITTALS

A. Shop Drawings: Provide Shop Drawings, per requirements of Section 23 01 20. Submit assembly-type shop drawings showing unit dimensions, construction details, methods of assembly of components and field connection details.

B. Product Data: Submit manufacturer's technical data for fans, including specifications, capacity rating, dimensions, weights, materials, accessories furnished and installation instructions.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to fan. Submit manufacture's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

D. Maintenance Data: Provide manuals, per requirements of Section 23 01 40. Submit maintenance data and parts list for each type of fan, accessory and control. Include this data, product data, shop drawings and wiring diagrams in maintenance manual, in accordance with requirements of Division 1.

E. Start-up Report: Provide completed start-up form, per the requirements of Section 23 03 20.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver fans in factory-fabricated crates, containers or wrappings which properly protect fans from damage.

B. Store fans in original packaging and protect from weather and construction traffic. Wherever possible, store in doors. Where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle fans carefully to prevent damage, breaking, denting and scoring of finishes. Do not install damaged units or components; replace with new.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Subject to compliance with requirements, provide in-line centrifugal cabinet fans as manufactured by one of the following:

1. Cook (Loren) Co.
2. Greenheck Fan Corp.
3. Jenn Industries, Inc.
4. Penn Zephyr
5. Twin City

2.2 GENERAL REQUIREMENTS

A. Provide direct-driven centrifugal ceiling and in-line fans consisting of housing, wheel, fan, shaft, bearings, drive assembly, motor, disconnect switch, mounting brackets, hinged aluminum backdraft damper and accessories as scheduled and shown on the drawings.

B. The fan housing shall be of the rectangular design constructed of rigid structural members and formed galvanized steel panels with acoustical fiberglass lining.

C. The motor shall be mounted on the inside of the housing. The motor shall be open drip proof type with permanently lubricated sealed bearings and include impedance or thermal overload protection. Motor shall be mounted on vibration isolators. The motor disconnect shall be internal and of the plug-in or toggle switch type.

D. Fans shall be furnished with inlet grille or furnished for in-line arrangement as indicated on the drawings.

E. Provide each fan with the following options:

1. Four (4) mounting brackets for horizontal ceiling suspension or vertical mounting (see drawings).
2. Neoprene or rubber grommet type support isolators.

2.3 CENTRIFUGAL CEILING FANS (PLASTIC)

A. Fan wheel, housing, and integral outlet duct collar shall be injection molded from a specially engineered resin exceeding UL requirements for smoke and heat generation. The outlet duct shall have an aluminum backdraft damper with continuous aluminum hinge rod. The inlet box shall be minimum 22 gauge galvanized steel. Motor shall be isolation mounted to a one piece galvanized stamped steel integral motor mount/inlet. A field wiring compartment with disconnect receptacle shall be standard. To accommodate different mounting positions, an adjustable prepunched mounting bracket shall be provided.

B. Wheel shall be centrifugal forward curved type, injection molded of polypropylene resin. Wheel shall be balanced in accordance with AMCA Standard 204-96, Balance Quality and Vibration Levels for Fans.

2.4 CENTRIFUGAL CEILING FANS (STEEL)

A. Fan housing shall be minimum 20 gauge galvanized steel and acoustically insulated. Blower and motor assembly shall be mounted to a minimum 14 gauge reinforcing channel and shall be easily removable from the housing. Motor shall be mounted on vibration isolators. Unit shall be supplied with integral wiring box. Discharge position shall be convertible from right angle to straight through by moving interchangeable panels. The outlet duct collar shall include a reinforced aluminum damper with continuous aluminum hinge rod and nylon bushings. To accommodate different ceiling thickness, an adjustable prepunched mounting bracket shall be provided.

B. Wheel shall be centrifugal forward curved type, constructed of galvanized steel. Wheel shall be balanced in accordance with AMCA Standard 204-96, Balance Quality and Vibration Levels for Fans.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which fans are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF FANS AND ACCESSORIES

A. General: Except as otherwise indicated or specified, install fans in accordance with manufacturer's installation instructions and recognize industry practices to insure that ventilators serve their intended function.

B. Coordinate fans and accessories with work of walls and ceilings, as necessary for proper interfacing.

C. Install ceiling suspended fans from overhead structure utilizing rubber grommet type isolators furnished by the fan manufacturer.

3.3 ELECTRICAL WIRING

A. Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer wiring diagram submittal to Electrical Installer.

B. Verify that motors and electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 Sections. Verify proper rotation directions of fan wheels. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

C. Remove shipping bolts, blocks and temporary supports within fans. Adjust dampers for free operation.

3.4 FIELD QUALITY CONTROL

A. Testing: After installation of fans has been completed, test each fan to demonstrate proper operation of units at performance requirements specified. When possible, field correct malfunctioning units, and then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected.

3.5 ADJUSTING AND CLEANING

A. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 23 50 18

SECTION 23 50 50
PROPELLER FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies down-blast centrifugal roof fans and air distribution equipment and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

C. Extent of work required for fans is indicated by drawings and schedules and as specified herein.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of fans, of types, ratings and capacities required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 CODES AND STANDARDS

A. AMCA Compliance: Provide fans which have been tested and rated in accordance with AMCA standards and bear AMCA Certified Rating Seal.

B. UL Compliance: Provide fans which are listed by UL and have UL label affixed.

C. UL Compliance: Provide fans which are designed, manufactured and tested in accordance with UL 705 "Power Ventilators".

D. NEMA Compliance: Provide motors and electrical accessories complying with NEMA standards.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

C. Start-up Report:

1. Provide completed start-up form, per the requirements of Section 23 03 20.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver fans in factory-fabricated crates, containers or wrappings which properly protect fans from damage.

B. Store fans in original packaging and protect from weather and construction traffic. Wherever possible, store in doors. Where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle fans carefully to prevent damage, breaking, denting and scoring of finishes. Do not install damaged units or components; replace with new.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide down-blast centrifugal roof fans as manufactured by one of the following:

1. Greenheck Fan Corp.
2. Cook (Loren) Co.
3. New York Blower Company
4. Twin City

2.2 BELT DRIVE SIDEWALL MOUNTED PROPELLER FANS

A. General Description:

1. Fan arrangement shall be either supply or exhaust, see Fan Schedule
2. Sidewall mounted applications
3. Maximum continuous operating temperature 130 Fahrenheit (54.4 Celsius)
4. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number

B. Wheel:

1. Constructed of welded steel blades and hubs
2. Securely attached to fan shaft with a standard square key and set screw or tapered bushing
3. Statically and dynamically balanced in accordance to AMCA Standard 204-05
4. The propeller and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency

C. Motors:

1. Motor enclosures: Open drip proof
2. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and furnished at the specific voltage and phase
3. Accessible for maintenance

D. Shafts and Bearings:

1. Fan Shaft shall be ground and polished solid steel with an anti-corrosive coating
2. Bearing shall be cast iron pillow block with grease fittings
3. Bearings shall be selected for a minimum L10 life in excess of 100,00 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed
4. Bearing shall be air handling quality and 100% factory tested by bearing manufacturer
5. Fan Shaft first critical speed is at least 25 percent over maximum operating speed

E. Drive Frame:

1. Bolted structural steel channel construction
2. Shall be galvanized steel with one piece drawn venturi
3. One-piece motor/bearing plate on sizes 24-36 and two piece sizes on 42-72

F. Disconnect Switches:

1. NEMA rated: 1
2. Positive electrical shut-off
3. Wired from fan motor to junction box

G. Drive Assembly:

1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower
2. Belt: Static free and oil resistant
3. Readily accessible for maintenance
4. Fully machined cast iron pulleys, keyed and securely attached to the wheel and motor shafts
5. The motor pulley shall be adjustable for final system balancing

2.3 Options/Accessories:

A. Closure Angles:

1. Extra set of mounting flanges shall be available for field installation to close off the interior wall opening for a finished appearance

B. Dampers:

1. Type: Motorized
2. Prevents outside air from entering back into the building when fan is off
3. Balanced for minimal resistance to flow
4. Galvanized frames with pre-punched mounting holes

C. Dampers Guards:

1. Guard material: Aluminum for intake fans, galvanized for exhaust fans
2. Shall completely enclose the damper or wall opening on the discharge side of the fan

D. Diffusers:

1. Constructed of heavy gauge galvanized steel frame and blades
2. Shall have pre-punched mounting flanges
3. Designed to mount to the interior end of the wall housing when used in the supply configuration

E. Finishes:

1. Types: Baked Enamel

F. Wall Housing:

1. Mounting arrangement: Motor Access Interior
2. Constructed of galvanized steel with heavy gauge mounting flanges and pre-punched mounting holes
3. Housing shall include OSHA approved motor guard
4. Reduces installation time and provides maximum installation flexibility

G. Wall Collar:

1. Constructed of galvanized steel with heavy gauge mounting flanges and pre-punched mounting holes

H. Motor Side Guard:

1. Guard type: OSHA Guard
2. Protective guard completely enclose the motor and drive side of the fan

I. Weatherhood Kit:

1. Shall shield wall opening and dampers from rain and snow
2. Material type: Aluminum
3. Turndown Angle: 45 degrees
4. Screen: Birdscreen
5. Finishes: Baked Enamel

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

A. Compliance: Comply with manufacturer's product data, including technical bulletins, product catalog installation instructions

3.2 EXAMINATION

A. Examine areas to receive fans. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization and maintenance of fans. Do not proceed with installation until unsatisfactory conditions are corrected

3.3 PREPARATION

A. Ensure roof openings are square, accurately aligned, correctly located, and in tolerance Ensure duct is plumb, sized correctly, and to proper elevation above roof deck. Install duct as specified in Air Distribution (Division 23)

3.4 INSTALLATION

A. Install fans system as indicated on the Installation, Operation and Maintenance Manual (IOM) and contract drawings

B. Install fans in accordance with manufacturer's instructions

3.5 SYSTEM STARTUP

A. Refer to Installation, Operation, and Maintenance Manual (IOM)

3.6 ADJUSTING

A. Adjust exhaust fans to function properly

B. Adjust Belt Tension

C. Lubricate bearings

D. Adjust drive for final system balancing

E. Check wheel overlap

3.7 CLEANING

A. Clean as recommended by manufacturer. Do not use material or methods which may damage finish surface or surrounding construction

3.8 PROTECTION

A. Protect installed product and finished surfaces from damage during construction. Protect installed exhaust fans to ensure that, except for normal weathering, fans will be without damage or deterioration at time of substantial completion

END OF SECTION 23 50 50

SECTION 23 60 10
PACKAGED ROOFTOP UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section includes packaged, outdoor, rooftop heating and cooling units (rooftop units) with the following components and accessories:

1. Direct-expansion cooling
2. Economizer outdoor and return-air damper section
3. Roof curb

B. Provide all materials, equipment, labor, and supervision necessary to install and perform all work described in this section.

C. Rooftop units shall have their own microprocessor controller with BACnet interface.

1.3 DEFINITIONS

A. DDC: Direct-digital controls.

B. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, rooftop heating and cooling units.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

C. Start-up Report:

1. Provide completed start-up form, per the requirements of Section 23 03 20.

D. Data: For RTU's to include in emergency, operation, and maintenance manuals.

E. Warranty: Provide special 5-year refrigeration compressor warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. ARI Compliance:

1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTU's.
2. Comply with ARI 270 for testing and rating sound performance for RTU's.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with ASHRAE/IESNA 90.1 for minimum efficiency of heating and cooling.

C. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

D. UL Compliance: Comply with UL 1995.

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

1.6 HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Protect units from physical damage. Leave factory shipping covers in place until installation.

1.7 WARRANTY

A. Manufacturer's standard form in which manufacturer agrees to replace components of RTU's that fail in materials or workmanship within specified warranty period.

B. Warranty Period:

1. Unit: One year from start-up or eighteen months from shipment, whichever comes first.

2. Compressors: Five years from start-up or five years and six months from shipment, whichever comes first.

1.8 EXTRA MATERIALS

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

1. The Mechanical Contractor shall provide one additional set of fan belts for each belt-driven fan (after balancing).

2. The RTU Manufacturer shall provide one additional set of filters for each unit (two sets total).

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide units as manufactured by one of the following:

1. Aaon

2. Bryant

3. Carrier Corporation

4. Greenheck

5. Johnson Controls

6. McQuay

7. Trane

8. Valent

2.2 GENERAL UNIT DESCRIPTION

A. Unit(s) furnished and installed shall be packaged rooftop as scheduled on contract documents and these specifications.

B. Cooling performance shall be based on AHRI testing procedures.

C. Wiring internal to the unit shall be numbered for simplified identification.

D. Units shall be cULus listed and labeled, classified in accordance with cULus for Central Cooling Air Conditioners.

E. Unit(s) shall be factory assembled, internally wired, fully charged and consist of insulated weathertight casing with compressors, air cooled condenser coil, condenser fans, evaporator coil, filters, supply and/or exhaust motors and drives, unit controls, and gas heating.

F. Unit(s) shall be single piece construction as manufactured at the factory.

G. Unit(s) shall be factory run tested to include the operation of all fans, compressors, heat exchangers, safeties, limits, and control sequences.

H. Unit(s) shall have labels, decals, and/or tags to aid in the service of the unit and indicate caution areas.

2.3 UNIT CASING

A. General Fabrication Requirements for Casings:

1. Formed and reinforced single wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

1. Exterior Casing Thickness: minimum 0.052 inch thick.

C. Inner Casing Fabrication Requirements:

1. Inside Casing: Galvanized steel, minimum 0.034 inch thick.

D. Casing Insulation: Comply with NFPA 90A or NFPA 90B.

1. Materials: ASTM C 1071, Type I.

2. Thickness: 1 inch.

3. Provide foil faced fiberglass insulation on all exterior panels and roof in contact with the return and conditioned air stream. Where top cover seams exist, they shall be double hemmed and gasket sealed to prevent water leakage.

E. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.

1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.

2. Drain Connections: Threaded nipple on one side of drain pan.

F. Access Doors: Fully-gasketed and hinged access doors with hold-back apparatus shall provide access to filters, supply air fan section, evaporator coil section, gas burner and unit controls.

2.4 FANS

A. Supply-Air Fans:

1. Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing.

2. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

3. Fan shaft shall be mounted on grease lubricated ball bearings.

4. All motors shall be circuit breaker protected.

5. Provide EISA rated motors for supply and exhaust fans.

6. Provide Internal Shaft Grounding Ring. Motors shall have internal bearing protection for use with VFDs.

B. Condenser-Coil Fan:

1. Propeller type, mounted on shaft of permanently lubricated motor.

C. Powered Exhaust-Air Fan:

1. RTU-1,2,3: Modulating 100% Exhaust Fan with Statitrac Control Option shall include a differential pressure control system, Statitrac, shall use a differential pressure transducer to compare indoor building pressure to outdoor ambient atmospheric pressure and shall turn the exhaust fans on and off and modulate the barometric exhaust dampers to control the building pressure to within the adjustable, specified dead band that shall be adjustable at the RTVM board

2. RTU-4: Factory installed, 100% power exhaust.

D. Flexible connector shall be factory fabricated with fabric strip attached to 2 strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized-steel sheet.

1. Flexible connector fabric shall consist of glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.

a. Fabric Minimum Weight: 26 oz./sq. yd.

b. Fabric Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.

c. Fabric Service Temperature: Minus 40 to plus 200° F.

2.5 GAS FIRED HEATING SECTION

A. Completely assembled and factory-installed heating system shall be integral to unit, cULus approved specifically for outdoor applications for use downstream from refrigerant cooling coils. Threaded connection with plug or cap provided. Provide capability for gas piping connection through side of unit.

B. Heating section shall be factory run tested prior to shipment.

C. Gas Burner shall be forced combustion type power burner and shall include negative pressure gas valve, manual shut-off, hot surface ignition, and flame sensing safety control.

D. Gas Burner Safety Controls: Provide safety controls for the proving of combustion air prior to ignition, and continuous flame supervision. Upon a failure to ignite, three attempts of ignition will occur before lockout of the ignition system.

E. Combustion blower shall be centrifugal type fan with built-in thermal overload protection on fan motor.

F. Heat Exchanger: Provide drum and tube heat exchanger of free floating design manufactured from 14-gauge 304 stainless steel drum and 16-gauge 304 stainless steel tubes. Factory pressure and leak tested.

G. Limit controls: High temperature limit controls will shut off gas flow in the event of excessive temperatures resulting from restricted indoor airflow or loss of indoor airflow.

H. RTU-1,2,3: Modulating Gas Heaters shall be stainless steel. The heater shall have a turn down ratio of 5 to 1.

I. RTU-4: Two-stage gas heat with stainless steel heat exchanger.

2.6 EVAPORATOR COIL

A. Provide heavy duty aluminum fins mechanically bonded to internally enhanced, copper tubes.

B. Provide a thermostatic expansion valve for each refrigeration circuit. All coils shall be leak tested at the factory to ensure pressure integrity. The evaporator coil is pressure tested to 450 psig.

C. Unit shall include Sloped Stainless Steel evaporator coil drain pans that are durable, long-lasting and highly corrosion resistant.

2.7 CONDENSER SECTION

A. Provide all Aluminum Microchannel condenser coils. All condenser coils shall be leak tested at the factory to ensure pressure integrity and pressure tested to 650 psig.

B. Provide integral subcooling circuit(s) to prevent premature refrigerant flashing and to insure maximum operating efficiency.

C. Provide vertical discharge, direct drive fans with steel blades, and three phase motors. Fans shall be statically balanced. Motors shall be permanently lubricated, with built-in current and thermal overload protection in a weathertight casing.

D. Furnish unit with factory installed low ambient capability to allow for operation down to 0 F. Hot Gas Bypass shall not be acceptable

E. Coil Split: Interlaced. For units 10 tons and larger.

F. Provide wire mesh coil guards coil guards on condensing section to protect unit piping and coils from damage.

G. Provide tool-less factory installed corrosion resistant louvered hail/vandalism guards to protect condenser coils from hail or physical damage. Wire mesh coil guards shall not be acceptable

H. Provide Corrosion Protected Condenser Coil that includes an all aluminum microchannel condenser coil with a corrosion resistant coating that shall withstand ASTM B117 Salt Spray test for 6,000 hours and ASTM G85 A2 Cyclic Acidified Salt Fog test for 2,400 hours. This coating shall be added after coil construction covering all tubes, headers and fin edges, therefore providing optimum protection in more corrosive environments.

2.8 REFRIGERATION SYSTEM

A. R410A refrigerant:

B. Compressor: Hermetic compliant scroll compressor operating at 3600 rpm with isolated mounting, centrifugal oil pump, oil sight glass, and compressor service valves

C. Provide factory installed service valves which include suction, liquid, and discharge 3-way shutoff valves.

D. Provide with thermostatic temperature motor winding control for protection against excessive temperatures caused by over-/undervoltage operation or loss of charge. Also provide high and low pressure cutouts.

E. Provide integral coil frost protection based on refrigerant circuit suction temperature to prevent coil frosting with minimum energy usage for all units. Hot Gas Bypass shall not be acceptable.

F. Units shall have cooling capabilities down to 0 degree F as standard or manufacturer shall furnish unit with installed low ambient controls to allow for operation down to 0 degree F. For field installed low ambient accessory, the manufacturer shall provide a factory authorized serviceman that will assure proper installation and operation.

G. Provide a High Efficiency Unit (eStage) which shall provide five stages of mechanical cooling with the ability to be at or below 25% compressor displacement at stage one. Achieving this through Hot Gas Bypass shall be unacceptable.

2.9 AIR FILTRATION

A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. RTU-1,2,3: Four-inch Pleated Throwaways, MERV 14.

2. RTU-4: Two-inch pleated throwaways, MERV 13.

2.10 DAMPERS

A. Outdoor- and Return-Air Mixing Dampers: Parallel -blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

B. Damper Motor: Electric, factory furnished by the manufacturer, compatible with the building automation system.

C. Provide a fully integrated factory installed 100% modulating outside air economizer with unit return and barometric relief air dampers. Economizer operation shall be through microprocessor based primary temperature controls that automatically modulate dampers to maintain space temperature conditions.

D. Provide spring return motor for outside air damper closure during unit shutdown or power interruption.

E. RTU-1,2,3: Provide Outside Air Measurement (Traq). A factory mounted airflow measurement station (Traq) shall be provided in the outside air opening to measure airflow. The airflow measurement station shall measure from 40 cfm/ton maximum airflow. The airflow measurement station shall adjust for temperature variations. Measurement accuracy shall meet requirements of LEED IE Q Credit 1 as defined by ASHRAE 62.1-2007.

F. RTU-1,2,3: Provide duct mounted CO2 sensor to monitor space occupancy levels within the building by measuring the parts per million of CO2 (Carbon Dioxide) in the air. As CO2 levels increase, the economizer fresh air damper shall modulate to meet the CO2 space ventilation requirements.

2.11 ECONOMIZER DAMPERS

A. Provide Standard Leakage Economizer Dampers. The return air and fresh air dampers shall be provided with airfoil blades and independent direct drive actuators. Dampers shall have a leakage rate of 3 CFM/sq-ft at 1.0 in WC pressure differential(AMCA Class 1A). Dampers shall have a functional life of 60,000 opening & closing cycles.

B. Note: Based on testing completed in accordance with AMCA Standard 500D.

C. Provide Fault Detection and Diagnostic (FDD) control. FDD control shall monitor the commanded position of the economizer compared to the feedback position of the damper. If the damper position is outside +/- 10% of the commanded position, a diagnostic is generated.

2.12 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with control-circuit transformer with built-in overcurrent protection.

B. Factory-made penetrations shall be provided for connection of all electrical wiring. These wiring provisions shall be through the Field penetrations of the unit base pan shall not be acceptable.

C. Unit shall include a phase monitor as standard that protects equipment from phase loss, phase reversal, and low voltage. Any fault condition shall produce a Failure Indicator LED, and send the unit into an emergency stop condition. The entire unit with this option shall be cULus approved. If not, a field UL inspection is required.

D. Unit shall include a factory-installed non-fused disconnect switch which satisfies NEC requirements for a service disconnect switch. Disconnect handle shall be accessible through the control box door such that high voltage power must be off before door can be opened.

E. Unit shall include a High Fault Unit Interrupt Rating (Short Circuit Current Rating-SCCR). 65,000 Amp rating (480V) or 25,000 Amp rating (600V) shall be applied to the unit enclosure using a non-fused circuit breaker for disconnect switch purposes. Fan motors, compressors, and electric heat circuits shall be provided with series rated circuit breakers that will provide the unit rated level of protection. The unit shall be marked with approved cULus markings and will adhere to cULus regulations.

2.13 CONTROLS

A. RTU manufacturer shall provide a microprocessor controller, remote space temperature sensor and all dampers, actuators, refrigeration safeties, hot gas and condenser fan controls and relays

B. Manufacturer shall furnish unit controller with a BacNet MSTP connection for integration into the Building Automation System.

C. Basic Unit Controls:

1. Unit shall be complete with self-contained low-voltage control circuit protected by a resettable circuit breaker on the 24-volt transformer side. Unit shall incorporate a lockout circuit which provides reset capability at the unit, should any of the following standard safety devices trip and shut off compressor: Loss-of-change/low-pressure switch; high-pressure switch, evaporator coil, freeze-protection thermostat. If any of the above safety devices trip, a LED (light-emitting diode) indicator shall flash a diagnostic code that indicates which safety switch has tripped. Unit shall incorporate "Auto Reset" compressor over temperature and over current protection. Unit shall have a bacnet interface to allow the building automation system to control or monitor the following:

a. Unit start/stop.

b. Supply fan alarm status.

C. Compressor energize/de-energize (each compressor). Minimum run timer and refrigeration systems safeties provided with factory installed controls.

d. Compressor/refrigeration systems alarm.

e. Outside air and return air dampers modulation.

2. Unit control board shall have on-board diagnostics and fault code display. Standard controls shall include anti-short cycle and low voltage protection, and permit cooling operation down to 50ºF. Control board shall monitor each refrigerant safety switch independently. Control board shall retain last 5 fault codes in non volatile memory, which will not be lost in the event of a power loss.

2.14 CONTROLS

A. General:

1. Microprocessor controls shall be provided for all 24 volt control functions.

2. The resident control algorithms shall make all heating, cooling and/or ventilating decisions in response to electronic signals from sensors measuring indoor and outdoor temperatures. The control algorithm maintains accurate temperature control, minimizes drift from set point and provides better building comfort.

3. A centralized microprocessor shall provide anti-short cycle timing and time delay between compressors to provide a higher level of machine protection.

B. Variable Air Volume Controls: Provide all necessary controls to operate a VAV rooftop from supply air temperature including supply air microprocessor controller, and supply air sensor. The microprocessor shall coordinate the economizer control and stages of cooling with supply air temperature reset capability based upon <<RESET_BASIS>> temperature.

C. The following setpoints shall be accessible in the unit control panel: supply air cooling setpoint, morning warmup setpoint, reset setpoint, reset amount, static pressure setpoint, and static pressure deadband.

D. Variable Air Volume controls with Variable Frequency Drive: Provide variable air volume supply air temperature control with variable frequency drive. Provide all necessary controls to operate a VAV rooftop from supply air temperature including microprocessor controller and supply air sensor. The microprocessor shall coordinate the economizer control and stages of cooling with supply air temperature reset capability based upon temperature. Variable frequency drive shall be factory installed and tested to provide supply fan motor speed modulation based upon the supply air static pressure setpoint.

E. The following setpoints shall be accessible in the unit control panel: supply air cooling setpoint, morning warmup setpoint, reset setpoint, reset amount, static pressure setpoint, and static pressure deadband.

F. Compensated Outside Air Control - shall be provided to control outside air damper positioning, maintaining minimum outside air requirements, during operation of variable air volume (VAV) systems.

G. Ventilation Override: Provide factory installed, tested, and commissioned ventilation override controls. Binary input from independent fire/life safety panel shall cause unit to override standard operation and assume one of two factory preset ventilation sequences: purge or pressurization.

H. Clogged filter indication: Provide factory installed differential pressure switch to indicate filter replacement status. Differential pressure switch shall cause a contact closure to display a service indication and unit will continue to operate normally.

2.15 BUILDING MANAGEMENT SYSTEM

A. Interface control module to Building Management System to be furnished factory mounted by rooftop unit manufacturer. Through this interface module, all Building Management functions (specified in Energy Management Section) shall be performed. See Building Automation and Automatic Temperature Control System Specifications. The interface module with necessary controls and sensors shall all be factory mounted (not field mounted). If not furnished by rooftop unit manufacturer, this shall be furnished by Building Management System Contractor for field mounting by said contractor and rated for service up to 140 F. The only field connection to Energy Management System shall be a single communication link.

B. Control Functions: Include unit scheduling, occupied/unoccupied mode, start-up and coast-down modes, nighttime free-cool purge mode, demand limiting, night setback, discharge air set point adjustment, timed override and alarm shutdown.

C. Diagnostic Functions shall include: Unit operating mode, Unit failure status, cooling failure, heating failure, emergency service stop indication, supply fan proving, timed override activation, high temperature thermostat status, Zone temperature, Supply air temperature, Cooling status (all stages), Stage activated or not, Stage locked out by UCP, HPC status for that stage, Compressor disable inputs, Heating status, Number of stages activated, High temperature limit status, Economizer status, Enthalpy favorability status, Requested minimum position, Damper position, Dry bulb/enthalpy input status, Outside air temperature, Outside relative humidity,] Sensor Failure: Humidity sensor, OAT sensor, SAT sensor, RAT sensor, Zone temperature sensor, Mode input, Cooling/heating setpoints from sensors (CV only), Static pressure transducer, Unit mounted potentiometer, SAT from potentiometer (VAV only), Air reset setpoint from potentiometer (VAV only), Unit Configuration data, Gas or electric heat, Economizer present, High temp input status, Local setpoint, Local mode,

2.16 ROOF CURBS

A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and facood nailer; complying with NRCA standards.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

A. Materials: ASTM C 1071, Type I or II.

b. Thickness: 1 inch.

2. Curb Height: minimum 14 inches.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Examine roughing-in for RTU's to verify actual locations of openings, piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where RTU's will be installed.

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

3.2 INSTALLATION

A. Roof Curb: The Mechanical Contractor shall provide the curb onto the roof; the General Contractor shall install on roof structure, level and secure.

B. Install all factory-furnished components that require field installation such as economizer hoods, filters, sensors, discharge pressure tubing, and gas heat thermisters.

3.3 CONNECTIONS

A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain.

B. Install piping adjacent to RTU's to allow service and maintenance.

C. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

D. Install ducts to termination at top of roof curb.

E. Install return-air duct continuously through roof structure.

F. The General Contractor shall remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb. Fill void with sound attenuating material as detailed.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing RTU's and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to compressor, coils, and fans.
3. Inspect internal insulation.
4. Verify that labels are clearly visible.
5. Verify that clearances have been provided for servicing.
6. Verify that controls are connected and operable.
7. Verify that filters are installed.
8. Clean condenser coil and inspect for construction debris.
9. Remove packing from vibration isolators.
10. Inspect operation of relief dampers.
11. Verify lubrication on fan and motor bearings.
12. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
13. Adjust fan belts to proper alignment and tension.
14. Start unit according to manufacturer's written instructions.
    a. Start refrigeration system.
    b. Complete startup sheets and attach copy with Contractor's startup report.
15. Inspect and record performance of interlocks and protective devices; verify sequences.
16. Operate unit for an initial period as recommended or required by manufacturer.
17. Adjust and inspect high-temperature limits.
18. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
19. Start refrigeration system and measure and record the following when ambient is a minimum of 15 °F above return-air temperature:
    A. Coil leaving-air, dry- and wet-bulb temperatures.
    B. Coil entering-air, dry- and wet-bulb temperatures.

c. Outdoor-air, dry-bulb temperature.

d. Outdoor-air-coil, discharge-air, dry-bulb temperature.

20. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.

21. Simulate maximum cooling demand and inspect the following:

a. Compressor refrigerant suction and hot-gas pressures.

b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.

22. After startup and performance testing and prior to Substantial Completion, replace filters with new filters.

3.6 CONTROLS INTEGRATION

A. The factory shall provide on-site technical support from an experienced controls technician employed by the unit's controller manufacturer to assist the Temperature Controls Sub-contractor with integration and controls commissioning of the unit.

3.7 CLEANING AND ADJUSTING

A. After start-up service, clean rooftop air-handling units internally on completion of installation on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.

B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.8 DEMONSTRATION

A. Demonstration services: Arrange and pay for a factory-authorized service representative to train owner's maintenance personnel for a minimum of two (2) hours on two separate days on the following:

1. Procedures and schedules related to start up and shut down, troubleshooting, servicing, preventative maintenance and hot to obtain replacement parts.

2. Familiarization with contents of Operating and Maintenance Manuals specified in other Division 23 Sections.

B. Schedule training with at least 7 days' advance notice.

End of Section 23 60 10

SECTION 23 73 10
SINGLE DUCT TERMINAL BOXES WITH HYDRONIC REHEAT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies single duct air terminal units (also called terminal boxes) with or without Hydronic reheat coils, and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. ARI Compliance: Provide coil ratings in accordance with ARI Standard 410 "Forced-Circulation Air-Cooling and Air-Heating Coils".

B. ASHRAE Compliance: Test coils in accordance with ASHRAE Standard 33 "Methods of Testing Forced Circulation Air Cooling and Heating Coils".

C. ADC Compliance: Provide air terminals which have been tested and rated in accordance with ADC standards and bear ADC Seal.

D. ARI Compliance: Provide air terminals which have been tested and rated in accordance with ARI 880 "Industry Standard for Air Terminals" and bear ARI certification seal.

E. NFPA Compliance: Construct air terminals using acoustical and thermal insulations complying with NFPA 90A "Air Conditioning and Ventilating Systems".

F. Air terminal units shall be constructed and installed per the following requirements:

1. SMACNA "HVAC Duct Construction Standards, Metal and Flexible".

2. ASHRAE standards for duct construction.

3. UL Compliance: Provide electrical components for terminal units and associated equipment which have been listed and labeled by UL.

G. Casing leakage shall be tested in accordance with ASHRAE 130.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver terminal units individually wrapped in factory-fabricated containers.

B. Handle terminal units carefully to prevent breakage, chipping and scoring fixture finish. Do not install damaged terminal units, replace and return damaged units to equipment manufacturer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Subject to compliance with requirements, provide air terminal units as manufactured by one of the following:

1. Trane
2. Envirotec
3. Krueger
4. Price
5. Titus
6. Metalaire
7. Carrier

2.2 GENERAL

A. Provide factory-fabricated and tested, pressure independent, air terminal units (also called terminal boxes) as indicated, selected with performance characteristics which match or exceed those indicated on the schedule.

B. At an inlet velocity of 2000 fpm, the differential static pressure required to operate any terminal size shall not exceed 0.18" w.g. for the basic terminal box. The static pressure drop of the complete assembly shall not exceed 0.35 w.g. for single duct terminal units for all sizes with a one-row reheat coil and with inlet velocities of 2,000 fpm or less. Sound ratings for each terminal box shall not exceed 35 NC at 1.0" static pressure. Sound performance shall be ARI certified

C. Identification: Provide label on each unit indicating plan number, cfm range, cfm factory setting and calibration curve.

2.3 CASING

A. Construct casing of galvanized sheet metal of minimum 22 gauge thickness. Provide hanger brackets for attachment of supports. The discharge connection shall be slip and drive construction for attachment to metal ductwork.

B. Construct casing with an insulated, gasketed access door for cleaning the re-heat coil. Casing shall be constructed to hold leakage to the maximum values shown in the Casing Leakage table.

1. The casing shall be constructed to hold leakage to the maximum values as follows:

a. Casing leakage for the basic assembly shall not exceed 1% of the maximum rated airflow at 1.0 in w.g.

b. Casing leakage for the basic assembly shall not exceed 2% of the maximum rated airflow at 3.0 in w.g.

2.4 LINING

A. Line inside surfaces of casings with lining material to provide acoustic performance, thermal insulation, and to prevent condensation on outside surfaces of casing.

B. Provide minimum thickness of ¾" closed cell polymer foam insulation which complies with UL 181 and NFPA 90A. Liner shall be fiber-free, low VOC, formaldehyde-free and non-particulating (won't erode, crack, flake or delaminate at higher air velocities). Fiberglass liner is not acceptable. Secure lining by mechanically fastening to unit casing to prevent delamination, sagging or settling.

****EDIT LINING TYPE****

****THE ABOVE LINING TYPE MEETS HOSPITAL REQUIREMENTS****

2.5 DAMPER

A. The damper shall be heavy gauge steel with shaft rotating in Delrin or bronze oilite self-lubricating bearings. Nylon bearings are not acceptable. Shaft shall be clearly marked on the end to indicated damper position. Stickers or other removable markings are not acceptable. The damper shall incorporate a mechanical stop to prevent overstroking and a synthetic seal to minimize close-off leakage to the maximum values as follows:

Inlet Size	Damper Close-off Leakage (CFM at 3" W.G. static pressure)
4, 5, 6	5
7, 8	5
9, 10	5
12	5
14	6
16	7

2.6 DAMPER ACTUATORS

A. Actuators shall be capable of supplying at least 35 in.-lb. of torque to the damper shaft and shall be mounted externally for service access. Actuator shall be direct connection shaft mount type without linkage.

B. Actuators shall be supplied by the Controls Contractor and factory or field installed.

2.7 VELOCITY SENSORS

A. The pneumatic inlet velocity sensors shall be multi-port center averaging type, with a minimum of four measuring ports parallel to the take-off point from the sensor.

2.8 CONTROLS

A. Terminal box controllers shall be pressure independent Direct Digital Control (DDC) type, supplied by the Controls Contractor as described below and in other sections of this Division.

B. Each terminal box shall be provided with an integral, field or factory mounted and wired controller.The Controls Contractor shall ship the controller and actuator to the terminal box manufacturer for factory mounting, or the Controls Contractor shall field install controls in a factory furnished controls enclosure provided by the terminal box manufacturer.

C. Terminal box controls shall be compatible with pneumatic inlet velocity sensors provided by the terminal box manufacturer.

D. The Controls Contractor shall provide the terminal box manufacturer with data sheets on all components to be mounted. Data sheets shall indicate component dimensions, mounting hardware and methods and wiring/piping diagrams for each application by unit mark number per the schedule on the drawings.

E. The terminal box manufacturer shall coordinate requirements with the Controls Contractor.

F. All controls shall be installed in the approved unit NEMA type sheet metal enclosure furnished and factory installed by the terminal unit manufacturer.

G. Terminal boxes shall be furnished with factory-installed Class II 120/24 VAC transformer and disconnect switch.

2.9 HEATING WATER REHEAT COILS

A. Hot water reheat coils shall be enclosed in a minimum 20 gauge galvanized steel casing with slip and drive construction for attachment to metal ductwork. Coils shall be factory installed on the terminal unit discharge.

B. Fins shall be rippled and corrugated heavy gauge aluminum, mechanically bonded to tubes.

C. Tubes shall be copper with minimum wall thickness of 0.016" with male solder header connections.

D. Coils shall be leak tested to 300 psi with minimum burst pressure of 2000 psi at ambient temperature.

E. The number of coil rows and circuits shall be selected to provide performance as required per the plans. Coil performance data shall be based on tests run in accordance with ARI Standard 410.

PART 3 - EXECUTION

3.1 GENERAL

A. Examine areas and conditions where terminal units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

B. Install all equipment as indicated on the drawings and in accordance with the manufacturer's installation instructions.

C. Provide five duct diameters of straight duct at inlet to each terminal unit. Flexible ductwork shall not be permitted at terminal units.

OR

D. Install flexible ductwork fully extended, free of sags and kinks at all box inlets. Maximum length of flexible ductwork shall be 3'-0". Fasten flexible ductwork to rigid ductwork and devices with self-locking 100 percent nylon, adjustable diameter clamps.

E. All air distribution equipment shall be supported per SMACNA requirements.

3.2 ELECTRICAL WIRING

A. Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer wiring diagram submittal to Electrical Installer.

B. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 Sections.

3.3 FIELD QUALITY CONTROL

A. Testing: After installation of boxes has been completed, test each box to demonstrate proper operation of units at performance requirements specified. When possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected.

3.4 ADJUSTING AND CLEANING

A. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 23 73 10

SECTION 23 74 20
SERIES FAN POWERED TERMINAL BOXES WITH HYDRONIC HEAT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies series fan powered air terminal units (also called fan powered boxes) with or without Hydronic reheat coils, and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. ARI Compliance: Provide coil ratings in accordance with ARI Standard 410 "Forced-Circulation Air-Cooling and Air-Heating Coils".

B. ASHRAE Compliance: Test coils in accordance with ASHRAE Standard 33 "Methods of Testing Forced Circulation Air Cooling and Heating Coils".

C. ADC Compliance: Provide air terminals which have been tested and rated in accordance with ADC standards and bear ADC Seal.

D. ARI Compliance: Provide air terminals which have been tested and rated in accordance with ARI 880 "Industry Standard for Air Terminals" and bear ARI certification seal.

E. NFPA Compliance: Construct air terminals using acoustical and thermal insulations complying with NFOA 90A "Air Conditioning and Ventilating Systems".

F. Air terminal units shall be constructed and installed per the following requirements:

G. SMACNA "HVAC Duct Construction Standards, Metal and Flexible".

H. ASHRAE standards for duct construction.

I. UL Compliance: Provide electrical components for terminal units and associated equipment which have been listed and labeled by UL.

J. Casing leakage shall be tested in accordance with ASHRAE 130.

1.4 SUBMITTALS

A. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver terminal units individually wrapped in factory-fabricated containers.

B. Handle terminal units carefully to prevent breakage, chipping and scoring fixture finish. Do not install damaged terminal units, replace and return damaged units to equipment manufacturer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Subject to compliance with requirements, provide air terminal units as manufactured by one of the following:

1. Envirotec
2. Johnson Controls
3. Price
4. Titus
5. Trane
6. Metalaire

2.2 GENERAL

A. Provide factory-fabricated and tested, pressure independent, air terminal units (also called terminal boxes) as indicated, selected with performance characteristics which match or exceed those indicated on the schedule.

B. At an inlet velocity of 2000 fpm, the differential static pressure required to operate any terminal size shall not exceed 0.18" w.g. for the basic terminal box. The static pressure drop of the complete assembly shall not exceed 0.35 w.g. for single duct terminal units for all sizes with a one-row reheat coil and with inlet velocities of 2,000 fpm or less.

C. Sound ratings for each terminal box shall not exceed 35 NC at 1.0" static pressure. Sound performance shall be ARI certified

D. Terminal units shall be parallel flow, constant supply air volume (FAN), variable primary air volume of sizes of capacities and with options as shown on the drawings. The primary air assemblies shall be pressure independent and shall reset to any air flow between zero and the maximum cataloged air volume.

E. The terminal shall be designed, build, and tested as a single unit including motor and fan assembly, primary air damper assembly, water or electric heating coils, and accessories as shipped. All electrical components shall be UL listed and installed in accordance with UL standard 1995. Electrical connection shall be mounted in a sheet metal control enclosures. The entire terminal shall be ETL listed as a complete assembly.

2.3 CASING

A. Construct of galvanized sheet metal of minimum 22 gauge thickness. Provide hanger brackets for attachment of supports. The discharge connection shall be slip and drive construction for attachment to metal ductwork.

A. Construct casing with an insulated, gasketed access door for cleaning the re-heat coil.

2.4 LINING

A. Line inside surfaces of casings with lining material to provide acoustic performance, thermal insulation, and to prevent condensation on outside surfaces of casing.

B. Provide minimum thickness of ¾” closed cell polymer foam insulation which complies with UL 181 and NFPA 90A.

C. Liner shall be fiber-free, low VOC, formaldehyde-free and non-particulating (won’t erode, crack, flake or delaminate at higher air velocities). Fiberglass liner is not acceptable.

D. Secure lining by mechanically fastening to unit casing to prevent delamination, sagging or settling.

2.5 DAMPER

A. The damper shall be heavy gauge steel with shaft rotating in Delrin or bronze iolite self-lubricating bearings. Nylon bearings are not acceptable. Shaft shall be clearly marked on the end to indicated damper position. Stickers or other removable markings are not acceptable. The damper shall incorporate a mechanical stop to prevent overstroking and a synthetic seal to minimize close-off leakage to the maximum values as follows:

Inlet Size	Damper Close-off Leakage (CFM at 3" W.G. static pressure)
4, 5, 6	5
7, 8	5
9, 10	5
12	5
14	6
16	7

2.6 DAMPER ACTUATORS

A. Actuators shall be capable of supplying at least 35 in.-lb. of torque to the damper shaft and shall be mounted externally for service access. Actuator shall be direct connection shaft mount type without linkage.

B. Actuators shall be supplied by the Controls Contractor and field installed.

2.7 VELOCITY SENSORS

A. The pneumatic inlet velocity sensors shall be multi-port center averaging type, with a minimum of four measuring ports parallel to the take-off point from the sensor.

2.8 CONTROLS

1. Terminal box controllers shall be pressure independent Direct Digital Control (DDC) type, supplied by the Controls Contractor as described above and in other Division 23 sections.

2. The Controls Contractor shall ship the controller and actuator to the terminal box manufacturer for factory mounting.

3. Terminal box controls shall be compatible with pneumatic inlet velocity sensors supplied by the terminal box manufacturer.

4. Controls Contractor shall provide the terminal box manufacturer with data sheets on all components to be mounted. Data sheets shall indicate component dimensions, mounting hardware and methods and wiring/piping diagrams for each application by unit mark number per the schedule on the drawings.

5. Terminal box manufacturer shall coordinate requirements with the Controls Contractor.

B. All controls shall be installed in approved NEMA type sheet metal enclosure by terminal manufacturer.

C. DDC terminal boxes shall be furnished with factory-installed Class II 24 VAC transformer and disconnect switch.

2.9 HEATING WATER REHEAT COILS

A. Hot water reheat coils shall be enclosed in a minimum 20 gauge galvanized steel casing with slip and drive construction for attachment to metal ductwork. Coils shall be factory installed on the terminal unit discharge.

B. Fins shall be rippled and corrugated heavy gauge aluminum, mechanically bonded to tubes.

C. Tubes shall be copper with minimum wall thickness of 0.016" with male solder header connections.

D. Coils shall be leak tested to 300 psi with minimum burst pressure of 2000 psi at ambient temperature.

E. The number of coil rows and circuits shall be selected to provide performance as required per the plans. Coil performance data shall be based on tests run in accordance with ARI Standard 410.

2.10 FAN

A. The fan assembly shall be constructed of steel with forward curved blades, dynamically balanced wheels and direct drive motor. The motor shall be suitable for scheduled single phase power. The motor shall be of energy efficient design, permanent split capacitor type, with integral thermal overload protection and permanently lubricated bearings, and be specifically designed for use with an SCR for fan speed adjustment. Fan assembly shall include a tuned spring steel suspension and isolation between motor and fan housing.

B. The terminals shall utilize an ECM motor, which allows fan speed adjustment from maximum to minimum, as a means of setting fan airflow. Setting fan airflow with any device that raises the pressure across the fan to reduce airflow is not acceptable. The speed control shall incorporate a minimum voltage stop to insure that the motor cannot operate in a stall mode.

C. The fan motor assembly shall be internally suspended and isolated from the unit casing using rubber isolators.

D. Provide a gasketed backdraft damper at the fan section outlet to prevent cold primary air from flowing back through the fan or into the return air duct.

E. Unit casing shall have a side or bottom access door to allow removal of fan and servicing of unit without disturbing duct connectors. Maximum unit height is 18".

2.11 ELECTRICAL

A. Units shall incorporate a single point electrical and control connection for the entire unit. All electrical components shall be enclosed in a single control box with an access panel mounted on the side of the assembly. All controls shall be sealed from primary air flow. Factory install and wire power line fusing, a disconnect switch and a 24 VAC transformer for control voltage on direct digital control units. Provide terminal strip in the control box or field wiring of thermostat.

2.12 IDENTIFICATION

A. Provide label on each unit indicating plan number, cfm range, cfm factory setting and calibration curve.

2.13 OPTIONS

A. Provide 1" filter frame on plenum return air opening with two sets of 1" thick disposable filters.

PART 3 - EXECUTION

3.1 GENERAL

A. Examine areas and conditions where terminal units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

B. Install all equipment as indicated on the drawings and in accordance with the manufacturer's installation instructions.

C. Install flexible ductwork fully extended, free of sags and kinks at all box inlets. Maximum length of flexible ductwork shall be 3'-0". Fasten flexible ductwork to rigid ductwork and devices with self-locking 100 percent nylon, adjustable diameter clamps.

D. All air distribution equipment shall be supported per SMACNA requirements.

3.2 ELECTRICAL WIRING

A. Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer wiring diagram submittal to Electrical Installer.

B. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 Sections.

3.3 FIELD QUALITY CONTROL

A. Testing: After installation of boxes has been completed, test each box to demonstrate proper operation of units at performance requirements specified. When possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected.

3.4 ADJUSTING AND CLEANING

A. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 23 74 20

SECTION 23 76 10
HYDRONIC UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies unit heaters equipment and accessories, and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. Unit heaters shall be provided with electric motors and components that are listed and labeled by Underwriters Laboratories and comply with NEMA standards.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

C. Start-up Report:

1. Provide completed start-up form, per the requirements of Section 23 03 20.

1.5 DELIVERY, STORAGE AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Units shall ship fully assembled up to practical shipping and rigging limitations. Units not shipped fully assembled shall have tags on each section to indicate location and orientation in direction of airflow. Each section shall have lifting points to allow for field rigging and final placement of section.

C. Store in a clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide unit heaters as manufactured by one of the following:

1. Airtherm
2. Carrier
3. Daikin
4. Modine

5. Sterling
6. Trane
7. Vulcan
8. York/Johnson
9. Rittling

2.2 CASINGS

A. Casings shall be minimum 20 gauge die-formed steel.

B. Casings shall be hot washed with iron phosphatizing clear rinse, oven dried and painted with a baked enamel finish.

2.3 FANS

A. Fans shall be factory balanced with aluminum spark proof blades and steel hubs.

B. Furnish vertical units with fan inlet guards.

C. Motors shall be totally enclosed, resilient mounted with class "B" windings and built-in thermal overload protection.

2.4 HYDRONIC COILS

A. Heating coils shall be suitable for use in steam or hot water applications.

B. Coil elements and headers shall be heavy wall drawn seamless copper tubing.

C. Element tubes shall be brazed into extruded header junctions.

D. Pipe connection saddles shall be of cast bronze.

E. Aluminum fins shall have drawn collars to assure permanent bond with expanded element tubes and exact spacing.

F. Elements shall be tested at 250 psi air pressure under water, under maximum load conditions.

2.5 ACCESSORIES

A. Furnish horizontal units with adjustable four-way air diffusion. Furnish vertical units with louver cone diffuser for air diffusion.

PART 3 - EXECUTION

3.1 GENERAL

A. All equipment shall be installed plumb and level, firmly anchored in locations indicated and in accordance with the equipment manufacturers recommendations.

B. All equipment shall be installed with adequate clearance provided for routine maintenance and servicing.

C. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.2 INSTALLATION

A. Install unit heaters as indicated, and in accordance with manufacturer's installation instructions.

B. Uncrate units and inspect for damage. Verify that nameplate data corresponds with unit designation.

C. Support units with rod-type hangers anchored to building substrate.

D. Install piping as indicated.

E. Protect units with protective covers during balance of construction.

3.3 ELECTRICAL WIRING

A. General: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to electric installer.

B. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 Sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

3.4 ADJUSTING AND CLEANING

A. General: After construction is completed, including painting, clean unit exposed surfaces, vacuum clean terminal coils and inside of cabinets and comb out coil fins.

B. Retouch any marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

END OF SECTION 23 76 10

SECTION 23 76 40
GAS-FIRED UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies gas-fired unit heaters and accessories, and includes general descriptions and installation methods.

B. Extent of gas-fired heater work required by this Section is indicated on drawings and schedules and by requirements of this section.

C. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of gas-fired equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

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

1.4 CODES AND STANDARDS

A. ANSI Compliance: Construct and install gas-fired unit heaters in accordance with ANSI Z83.8 “Gas Heaters”.

B. NFPA Compliance: Install fuel gas piping and gas-fired equipment in accordance with ANSI.

C. AGA Compliance: Design-certify and label gas-fired equipment accordance with the American Gas Association (AGA) requirements.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data, including rated capacities of selected model clearly indicated, weights, furnished specialties and accessories; and installation and start-up instructions.

B. Shop Drawings: Submit manufacturer’s assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

C. Wiring Diagrams: Submit manufacturer’s electrical requirements for power supply wiring for gas-fired unit heaters. Submit manufacturer’s ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

D. Maintenance Data: Submit maintenance data and parts list for each type of gas-fired unit heater, control, accessory; including “trouble-shooting” maintenance guide. Include this data and product data in maintenance manual; in accordance with requirements of Division 1.

1.6 DELIVERY, STORAGE AND HANDLING

A. Handle unit heaters and components carefully to prevent damage, breaking, denting, and scoring. Do not install damaged heaters or components; replace with new.

B. Store unit heaters and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

C. Comply with manufacturer's rigging and installation instructions for unloading gas-fired unit heaters and moving them to final location.

1.7 EXTRA MATERIALS

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

1. Burner Igniters: One hot-surface burner igniter for each style of gas-fired heater furnished. Obtain receipt from Owner.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide gas-fired unit heaters as manufactured by one of the following:

1. Detroit Radiant Products
2. Hastings Industries, Inc.
3. ITT Reznor
4. Modine Manufacturing Co.
5. Roberts-Gordon, Inc.

2.2 GENERAL

A. Provide gas-fired unit heaters as indicated, of type and minimum capacity as scheduled and as specified herein. Unit heaters shall consist of burners, ignition systems, tubular heat exchangers, burner safety controls, and fans. Units shall be designed to utilize ducted combustion air drawn from the outdoors.

B. Fuel type: burner shall be designed for natural gas having characteristics same as those of gas available at project site.

C. Unit Casing:

1. The heater casing shall be constructed of not less than 20 gauge aluminized steel.
2. The unit shall be furnished with air deflectors blades made of 304 series brushed stainless steel.
3. The deflector blades are adjustable to provide for directional airflow (up or down).

D. Furnace Section:

1. The tubular heat exchanger shall be constructed of a minimum of 18 gauge aluminized steel tubes.
2. The thermal efficiency of the unit shall be above 80%.
3. The burner shall be in-shot type, firing directly into each heat exchanger tube individually.

E. Ignition System:

1. Direct spark igniter with flame rod sensing capabilities.
2. Single-stage gas control.

F. Burner Safety Controls:

1. Heater controls shall include a safety differential pressure switch to monitor combustion air flow, as to provide complete burner shutdown due to insufficient combustion air or flue blockage.
2. The heater shall incorporate a self-diagnostic ignition module, and recycle the heater after an inadvertent shutdown.
3. The heater's control system shall be designed to shut off the gas flow to the main burner in the event either a gas supply or power supply interruption occurs.
4. The heater's blower motor shall be thermally protected and the motor's impeller shall be balanced.
5. Heater control assembly shall include two indicator lights that define the unit's operating features. One indicator shall validate air flow. One indicator light shall indicate gas valve energization.
6. An automatic reset high limit switch shall be mounted in the air stream to shut off the gas supply in the event of overheating.
7. A time delay relay shall be incorporated that delays the start of the air blower fan to allow the heat exchanger a warm-up upon a call for heat. A time delay relay shall be incorporated to continue the air blower fan operation after the thermostat has been satisfied to help remove any residual heat in the exchanger.
8. No condensation shall form in the exchanger tubes while at operating temperatures.

G. Air Movement:

1. The motor type shall be single-speed, totally enclosed.
2. The motor voltage shall be as scheduled on the drawings.
3. Swept winged fan blade designed to optimize air flow and reduce noise levels.
4. Stainless steel, adjustable air discharge louvers with seamless airfoil design to maximize airflow.

H. Venting:

1. Combustion air and flue vent shall be installed per manufacturer's specifications.
2. Vent materials shall be approved by manufacturer.

I. Accessories:

1. Furnish each unit with internally mounted control power transformer.
2. Furnish with concentric vent/intake roof adapter kit, where shown to be roof-vented.

J. Warranty:

1. The manufacturer shall provide a 1-year warranty on all electrical and mechanical operating components.
2. The manufacturer shall provide a 5-year limited warranty on the heat exchangers and a 10-year limited warranty on the burners.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which gas-fired unit heaters are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION

A. General: Install gas-fired unit heaters as indicated and in accordance with manufacturer's published installation instructions. Maintain manufacturers' recommended clearances to combustibles.

B. Hang units from substrate using threaded rods and building attachments, secure rods to unit hanger attachments. Adjust hangers so units are plumb and level.

C. Extend gas piping to within 5' from unit, provide drop with manual gas shut-off valve, 1/8" NPT plugged test connection, tee and dirt pocket. Locate piping drop so as to not interfere with service of unit. Extend gas piping runout, full size of gas train inlet, from tee to gas train connection, provide union with sufficient clearance for unit removal and service.

D. Extend combustion air pipe and flue from manufacturer-supplied roof terminal assembly to unit heater; make gas-tight connections.

3.3 START-UP

A. Start-up, test, and adjust gas-fired unit heaters in accordance with manufacturer's published start-up instructions.

B. Verify proper line and manifold gas pressure.

C. Check and calibrate controls; adjust burner for maximum efficiency.

3.4 ADJUSTING

A. Adjust initial temperature set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

C. Adjust air diffusion louvers for proper air flow.

END OF SECTION 23 76 40

SECTION 23 77 10
HYDRONIC CABINET UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies cabinet unit heaters and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 CODES AND STANDARDS

A. ARI Compliance: Provide coil ratings in accordance with ARI Standard 410 "Forced-Circulation Air-Cooling and Air-Heating Coils."

B. ASHRAE Compliance: Test coils in accordance with ASHRAE Standard 33 "Methods of Testing Forced Circulation Air Cooling and Heating Coils."

C. UL Compliance: Construct and install cabinet heaters in compliance with UL 883 "Safety Standards for Fan Coil Units and Room Fan Heater Units."

D. UL Compliance: Provide electrical components for cabinet unit heaters which have been listed and labeled by UL.

E. NFPA Compliance: Construct cabinet unit heaters using acoustical and thermal insulations complying with NFPA 90A "Air Conditioning and Ventilating Systems."

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

C. Start-up Report:

1. Provide completed start-up form, per the requirements of Section 23 03 20.

D. Furnish submittals are required per section 23 01 10 "Project Submittal Requirements"

1.5 DELIVERY, STORAGE AND HANDLING

A. Handle cabinet unit heaters and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged terminal units or components; replace with new.

B. Store cabinet unit heaters and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

C. Comply with manufacturer's rigging and installation instructions for unloading cabinet unit heaters and moving them to final location.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide cabinet unit heaters as manufactured by one of the following:

1. Airtherm
2. Carrier
3. Daikin
4. Modine
5. Sterling
6. Trane
7. Vulcan
8. York/Johnson
9. Rittling

2.2 GENERAL

A. Provide cabinet heaters having cabinet sizes and in locations as indicated, of capacities, style, and having accessories as scheduled, and herein specified. Include in basic unit: chassis, coil, fanboard, fan wheels, housings, motor, integral thermostat, and insulation.

2.3 CHASSIS

A. Galvanized steel wrap-around structural frame with edges flanged.

2.4 INSULATION

A. Faced, heavy density glass fiber.

2.5 CABINET

A. 16 gauge removable front panel, 18 gauge top and side panels.

B. Insulate front panel over entire coil section.

C. Provide access door on coil connection side.

D. Clean cabinet parts, bonderize, phosphatize, and flow-coat with baked on primer and final enamel coat.

E. Color shall be as selected by Architect.

F. For ducted horizontal units, provide inlet and outlet duct collars.

2.6 WATER COILS

A. Construct 1/2" or 5/8" seamless copper tubes mechanically bonded to configurated aluminum fins.

B. Design for 250 psi and leak test at 300 psi under water.

C. Provide same end connections for supply and return.

2.7 FANS

A. Provide centrifugal, forward curved double width fan wheels constructed of non-corrosive, molded fiberglass-reinforced thermoplastic material.

B. Construct fan scrolls of galvanized steel.

2.8 MOTORS

A. Provide permanent split capacitor motors with integral thermal overload protection, and motor cords for plug-in to junction box with unit.

2.9 FILTERS

A. Provide 1" thick throwaway type filters.

2.10 ACCESSORIES

A. Recessing Flanges: Provide 18-ga steel flanges for recessing cabinet heaters into wall or ceiling.

B. Sub-bases: Provide minimum 18-ga steel sub-base for vertical units of height as indicated.

C. Disconnect Switch: Nonfusible type, with thermal overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

D. Inlet and Discharge grille arrangements shall be as scheduled and shown on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install cabinet heaters as indicated, and in accordance with manufacturer's installation instructions. Uncrate units and inspect for damage. Verify that nameplate data corresponds with unit designation.

B. Locate cabinet heaters, plumb and level, firmly anchored in locations indicated. Coordinate with other traces to assure correct recess size for recessed units. Hang ceiling units from building substrate, not from piping. Support units with rod-type hangers anchored to building subtrate.

C. All equipment shall be installed with adequate clearance provided for routine maintenance and servicing. Locate horizontal, above-ceiling units to maintain access with ceiling components below.

D. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

E. Install piping as indicated.

F. Protect units with protective covers during balance of constructions.

3.2 ELECTRICAL WIRING

A. General: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electric Installer.

B. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 Sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

3.3 ADJUSTING AND CLEANING

A. General: After construction is complete, including painting, clean unit exposed surfaces, vacuum clean terminal coils and inside of cabinets and comb out coil fins.

B. Retouch any marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by the manufacturer.

C. Install new filters for cabinet heaters requiring same.

END OF SECTION 23 77 10

SECTION 23 77 30
ELECTRIC CABINET UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies electric unit heater equipment and accessories, and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of terminal units, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 CODES AND STANDARDS

A. AMCA Compliance: Comply with applicable requirements of the Air Movement and Control Association's Publication Number 99, 203, and 311 pertaining to fan performance and sound ratings.

B. ASHRAE Compliance: Comply with applicable requirements of ASHRAE Handbook, Equipment Volume, Section III, pertaining to applications and installation of electric heating terminal units.

C. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction and NEC as applicable to construction and installation of electric heating terminal units.

D. IEEE Compliance: Comply with applicable recommended installation practices of IEEE Std 241, "Recommended Practice for Electric Power Systems in Commercial Building" pertaining to electric heating terminal units.

E. NEMA Compliance: Provide electric heating terminal units' accessories which comply with NEMA Standards.

F. UL Compliance: Construct and install cabinet heaters in compliance with UL 883 "Safety Standards for Fan Coil Units and Room Fan Heater Units."

G. UL Compliance: Provide electrical components for terminal units which have been listed and labeled by UL.

H. UL Compliance: Comply with applicable requirements of UL 1025 "Electric Air Heaters" and UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors."

1.5 DELIVERY, STORAGE AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Store in a clean dry place and protect from weather, dirt, water, physical damage, and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish. Do not install damaged terminal units or components; replace with new.

C. Deliver units to site with fan and motor completely assembled and mounted in units.

1.6 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

C. Start-up Report:

1. Provide completed start-up form, per the requirements of Section 23 03 20.

D. Product Data: Submit manufacturer's specification for electrical unit heaters showing dimensions, capacities, ratings, performance characteristics, gauges and finishes of materials and installation instructions.

E. Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, construction details, and field connections details.

F. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

G. Maintenance Data: Submit maintenance instructions, including lubrication instructions, motor replacement, and spare parts lists. Include this data, product data, and shop drawings in maintenance manual in accordance with requirements of Division 1.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide electric unit heaters as manufactured by one of the following:

1. Indeeco
2. Markel
3. Q'Mark (Chromalox)
4. Trane Company
5. Ouellet

2.2 GENERAL

A. Unit heaters shall be UL listed draw-thru design to provide uniform temperature across heater element and forced air cooling of motor with ambient air.

2.3 CABINET

A. 16 gauge removable front panel, 18 gauge top and side panels. Insulate front panel over entire coil section.

B. Adequate space shall be provided on both sides of internal cabinet for installation of control valves or electrical equipment. Provide access door on coil connection side.

C. Clean cabinet parts, bonderize, phosphatize, and flow-coat with baked on primer and final enamel coat. Color shall be as selected by Architect.

D. Extruded architectural style aluminum discharge grille shall be tamper resistant.

2.4 HEATING ELEMENT

A. Heater elements shall be corrosion protected, steel plate fin type with elements brazed to common fins for maximum strength and heat transfer.

B. Automatic reset thermal cutout for each element assembly shall provide protection from over-temperature.

2.5 MOTORS

A. Provide squirrel cage motors with integral thermal overload protection, and motor cords for plug-in to junction box within unit.

B. All motors shall have permanently lubricated bearings, built-in thermal protection and shall be completely enclosed. Motors shall have ball bearings. Separate motor supply circuits shall not be required.

2.6 FANS

A. Fans shall be squirrel cage, with two speed operation.

B. Operating sound shall not exceed 48 dBA at low speed and 50 dBA at high speed.

C. Construction shall be aluminum, directly connected to the fan motor.

D. Units shall have a thermal fan delay to dissipate all residual heat from heater cabinet and recirculate ambient air until temperature drops to 90°F for maximum energy savings.

E. All metal surfaces of the cabinet shall be protected by baked enamel finish.

2.7 FILTERS

A. Provide 1" thick throwaway type filters.

2.8 SUPPLY CIRCUIT

A. All units to have a single supply circuit with fuses as required by NEC for element and motor protection. Automatic control shall delay fan operation until heating element is warm. When heat shuts off, the fan shall continue to operate until residual heat has been dissipated.

2.9 SAFETIES

A. High-level cutout shall automatically shut off current in event of overheating and reactivate heater when temperature returns to normal.

2.10 ACCESSORIES

A. Provide units with the following:

1. 24 volt controls (including transformer and remote wall thermostat).
2. Main disconnect switch, factory installed.
3. Inlet and Discharge grille arrangements shall be as shown on the drawings.

PART 3 - EXECUTION

3.1 GENERAL

A. Install electric heating equipment including components as indicated in accordance with equipment manufacturer's written instructions and with recognized industry practices, complying with applicable installation requirements of the National Electric Code. Unpack units and inspect for damage. Verify that nameplate data corresponds with unit designation.

B. Coordinate with other electrical work, including wiring/cabling as necessary to properly interface installation of heating equipment with other work.

C. Clean dust and debris from each heating terminal unit as it is installed to ensure cleanliness. Protect units with protective covers during balance construction.

D. Comb out damaged fins where bent or crushed before covering elements with enclosures.

E. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A.

3.2 GROUNDING

A. Provide equipment grounding connections for electric heating equipment as required by NEC. Tighten Connections to comply with tightening torque values specified in UL Std 486A to assure permanent and effective grounding.

3.3 ELECTRICAL WIRING

A. Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to electrical installer.

1. Verify that electrical wiring installation is in accordance with the manufacturer's submittal and installation requirements of Division 16 Sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

3.4 TESTING AND CLEANING

A. After construction is completed, including painting, clean unit exposed surfaces, vacuum clean heating coils and inside of cabinets.

B. Retouch any marred or scratched surfaces of factory finished cabinets, using finish materials furnished by manufacturer.

C. Upon completion of installation of electric heating equipment and after building circuitry has been energized, test units to demonstrate capability and compliance with requirements. Where possible, correct in the field malfunctioning units, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

D. Replace electric heating equipment and accessories that are damaged and remove damaged items from construction site.

END OF SECTION 23 77 30

SECTION 23 81 10
DUCTLESS SPLIT AIR CONDITIONING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

C. Provide motors as described elsewhere in these specifications.

1.2 SCOPE

A. This Section specifies Direct Expansion (DX) split air conditioning units and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 QUALITY ASSURANCE

A. Units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label.

B. All wiring shall be in accordance with the National Electrical Code (N.E.C.) and local codes as required.

C. Units shall be rated in accordance with Air-conditioning, Heating, and Refrigeration Institute's (AHRI) Standard 210 and bear the ARI Certification label.

D. Units shall be manufactured in a facility registered to ISO 9001 and ISO 14001, which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).

E. A nitrogen holding charge shall be provided in the indoor (evaporator) section at the time of shipment.

F. The outdoor unit shall be pre-charged with an adequate amount of R-410a refrigerant to accommodate 70 feet of refrigerant tubing.

G. Manufacturer shall have over ten (10) years of continuous experience in the U.S. market.

1.4 CODES AND STANDARDS

A. Equipment, materials and installation shall comply with the Ohio Mechanical Code, the Ohio Pressure piping Code, and all requirements of the local authorities having jurisdiction.

B. Refrigeration system and condensing units shall be constructed and installed in accordance with latest ASHRAE Standard "Safety Code for Mechanical Refrigeration".

C. Equipment shall be listed by UL and have UL label affixed.

1.5 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

C. Start-up Report: Provide completed start-up form, per the requirements of Section 23 03 20.

D. Furnish submittals are required per section 23 01 10 "Project Submittal Requirements"

1.6 WARRANTY

A. Units shall have a manufacturer's parts and defects warranty for a period five (5) year from date of installation. The compressor shall have a warranty of seven (7) years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer. This warranty does not include labor.

B. Manufacturer shall have over ten (10) years of continuous experience in the U.S. market.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. All DX Split Air Conditioning System equipment shall be provided by one manufacturer. Subject to compliance with requirements, provide equipment by one of the following acceptable manufacturers:

1. Daikin
2. Friedrich
3. Mitsubishi
4. Sanyo
5. Toschiba/Carrier

2.2 SYSTEM COOLING PERFORMANCE

A. Cooling performance shall be based on 80°F dry bulb, 67°F wet bulb for the indoor unit and 95°F dry bulb, 75°F wet bulb for the outdoor unit.

2.3 SPLIT SYSTEM INDOOR UNITS

A. Wall-Mounted Type

1. Indoor, wall-mounted unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, control circuit board and fan motor. The unit, in conjunction with the wired, wall mounted controller or wireless handheld controller, shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be purged with dry nitrogen before shipment from the factory.
2. Unit Cabinet: The cabinet shall be formed from high strength molded plastic with smooth finish, flat front panel design with access for filter. Cabinet color shall be white. The unit shall be wall mounted by means of a factory supplied, pre-drilled, mounting plate.
3. Fan: The indoor unit fan shall be high performance, double inlet, forward curve, direct drive sirocco fan with a single motor. The fans shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The indoor fan shall consist of three (3) speeds: Low, Mid, and Hi and Auto. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperature.

a. Indoor unit sound level shall not exceed the levels below:

Tonnage	Low Speed	Mid Speed	High Speed
1	36 dB(A)	40 dB(A)	43 dB(A)
1.5	36 dB(A)	40 dB(A)	43 dB(A)
2	39 dB(A)	42 dB(A)	45 dB(A)

2.5	39 dB(A)	42 dB(A)	45 dB(A)
3	43 dB(A)	46 dB(A)	49 dB(A)

4. Vane: There shall be a motorized horizontal vane to automatically direct air flow in a horizontal and downward direction for uniform air distribution. The horizontal vane shall significantly decrease downward air resistance for lower sound levels, and shall close the outlet port when operation is stopped. There shall also be a set of vertical vanes to provide horizontal swing airflow movement.

5. Filter: Return air shall be filtered by means of an easily removable washable filter.

6. Coil: The evaporator coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing. The multi-angled heat exchanger shall have a modified fin shape that reduces air resistance for a smoother, quieter airflow. All tube joints shall be brazed with PhosCopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil.

7. Option: A condensate mini-pump shall be provided to provide a means of condensate disposal when a gravity drain is not available. Lift mechanism shall incorporate a safety sensor system to shut down the indoor fan and the compressor in the outdoor unit in the event of high level of condensate in the drain pan.

8. Electrical: The electrical power of the unit shall be 208 volts or 230 volts, 1 phase, 60 hertz. The system shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts. The power to the indoor unit shall be supplied from the outdoor unit, using the Mitsubishi Electric A-Control system. For A-Control, a three (3) conductor AWG-14 wire with ground shall provide power feed and bi-directional control transmission between the outdoor and indoor units.

9. System Control: The indoor unit shall be connected to a wall mounted wired controller to perform input functions necessary to operate the system. The wired controller shall have a large multi-language DOT liquid crystal display (LCD) presenting contents. There shall be a built-in weekly timer with up to eight pattern settings per day. The controller shall consist of an On/Off button, Increase/Decrease Set Temperature buttons, a Heat/Cool/Auto/Dry mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Ventilation button, a Test Run button, and a Check Mode button. The controller shall have a built-in temperature sensor. Temperature shall be displayed in either Fahrenheit (°F). Temperature changes shall be by increments of 1°F with a range of 67°F to 87°F.

    a. The wired controller shall display operating conditions such as set temperature, room temperature, pipe temperatures (i.e. liquid, discharge, indoor and outdoor), compressor operating conditions (including running current, frequency, input voltage, On/Off status and operating time), LEV opening pulses, sub cooling and discharge super heat. Normal operation of the wired controller shall provide individual system control in which one wired controller and one indoor unit are installed in the same room. The controller shall have the capability of controlling up to a maximum of sixteen systems, as a group with the same mode and set-point for all, at a maximum developed control cable distance of 1,500 feet (500 meters).

    b. Control system shall provide On/Off and mode switching. The controller shall have the capability to provide sequential starting with up to fifty seconds delay.

    c. Furnish unit with condensate drain pan level sensor to shutdown unit and prevent drain pan overflow.

2.4 OUTDOOR AIR-COOLED CONDENSING UNITS

A. Condensing units shall be factory-assembled and tested, air-cooled, horizontal discharge type, consisting of compressor, condenser coil, fan, motor, refrigerant reservoir and operating controls.

B. Casing shall be zinc coated steel finished with baked enamel, complete with removable panels for access to controls and mounting holes in base. Unit shall be complete with flare fittings on exterior of casing. Mounting feet shall be provided and shall be welded to the base of the cabinet and be of sufficient size to afford reliable equipment mount and stability.

C. Compressor:

1. Compressors shall be hermetically sealed, with built-in overloads and vibration isolation.

2. The compressor for 1 to 3-ton units shall be a DC twin-rotor rotary compressor with Variable Speed Inverter Drive Technology. The compressor for 3-ton units shall be a Frame Compliant Scroll compressor with Variable Speed Inverter Drive Technology.

3. The compressor shall be driven by the inverter circuit to control compressor speed. The compressor speed shall dynamically vary to match the room load for significantly increasing the efficiency of the system which shall result in significant energy savings.

4. To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be automatically, intermittently applied to the compressor motor windings to maintain sufficient heat to vaporize any refrigerant. No crankcase heater is to be used.

5. The outdoor condensing unit shall have an accumulator and high pressure safety switch. The compressor shall be mounted to avoid the transmission of vibration.

D. Condenser coils:

1. The L-shaped condenser coil shall be of copper tubing with flat aluminum fins to reduce debris build up and allow maximum airflow. The coil shall be protected with an integral metal guard.

2. Refrigerant flow from the condenser shall be controlled by means of an electronic linear expansion valve (LEV) metering device. The LEV shall be controlled by a microprocessor controlled step motor.

E. Aluminum propeller fan shall be direct-driven with permanently lubricated or ball-bearing fan motor having thermal overload protection.

F. Furnish unit with wind baffle accessory for low ambient cooling down to 0°F outdoor air temperature.

G. Refrigerant charge: R-410A.

H. The outdoor unit shall be compatible with the indoor unit and shall be of the same capacity and same manufacturer as the indoor unit.

I. The outdoor unit shall be equipped with a control board that interfaces with the indoor unit to perform all necessary operation functions.

J. System shall operate at up to a maximum refrigerant tubing length of 100 feet for the 1-1.5-ton units and 165 feet for the 2-3.5-ton units between indoor and outdoor units without the need for line size changes, traps or additional oil. 1 to 3-ton units shall be pre-charged to accommodate a maximum of 70 feet of refrigerant tubing; 3.5-ton units shall be pre-charged for 100 feet.

K. The outdoor unit shall be completely factory assembled, piped, and wired. Each unit must be test run at the factory.

L. The outdoor unit shall be able to operate with a maximum height difference of 100 feet between indoor and outdoor units.

M. Outdoor unit sound level shall not exceed:

Tonnage	Cooling
1	46 dB(A)
1.5	46 dB(A)
2	48 dB(A)
2.5	48 dB(A)
3	48 dB(A)
3.5	51 dB(A)

N. Electrical

1. The electrical power of the unit shall be 208volts or 230 volts (see schedule), single phase, 60 hertz.
2. Power for the indoor unit shall be supplied from the outdoor unit.
3. The outdoor unit shall be controlled by the microprocessor located in the indoor unit.
4. The control signal between the indoor unit and the outdoor unit shall be pulse signal 24 volts DC.
5. The unit shall have Pulse Amplitude Modulation circuit to utilize 98% of input power supply.

2.5 UNIT CONTROLS

A. The control system shall consist of two microprocessors, one on each indoor and outdoor unit, interconnected by a single, non-polar two-wire cable. The system shall have self-diagnostics ability and shall be capable of automatic restart when power is restored after power interruption. The indoor unit shall be connected to a wall-mounted wired controller via 12VDC monitoring set temperature, room temperature, and compressor operation conditions. The control signal between the indoor and outdoor units shall be 24VDC.

PART 3 - EXECUTION

3.1 GENERAL

A. All equipment shall be installed plumb and level, in locations indicated and in accordance with the equipment manufacturer's recommendations.

B. All equipment shall be installed with adequate clearance provided for proper operation and routine maintenance and servicing.

3.2 DELIVERY, STORAGE AND HANDLING

A. Handle split DX air conditioning units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged terminal units or components; replace with new.

B. Store split DX air conditioning units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

C. Comply with manufacturer's rigging and installation instructions for unloading DX split air conditioning units and moving them to final location.

3.3 TESTING, CHARGING AND STARTUP

A. Test refrigerant piping system in accordance with Section 231040 "Refrigeration Piping".

B. Evacuate and charge system with refrigerant as required to place equipment in operation. Provide full operating charge.

C. Start-up, test, and adjust equipment in accordance with manufacturer's published start-up instructions. Verify proper line and manifold gas pressure. Check and calibrate controls.

END OF SECTION 23 81 10

SECTION 23 90 10
INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

B. Related Sections include the following:

1. 23 01 10 – Project Submittal Requirements
2. 23 02 10 – Owner Operating and Maintenance Training
3. 23 03 50 – Commissioning of Mechanical Systems and Components
4. 23 09 40 – Wire and Cable
5. 23 09 41 – Conduit Systems
6. 23 09 42 – Pulling Cables
7. 23 09 93 – Sequences of Operation

1.3 DEFINITIONS

A. The following acronyms are repeatedly used within this document.

AAC – Advanced Application Controller

AFF – Above Finished Floor

AHU – Air Handling Unit

ASC – Application Specific Controller

AWS – Advanced Work Station

BACnet – Building Automation Control Network

BAS – Building Automation System

BBMD – BACnet/IP Broadcast Management Device

BIBB – BACnet Interoperability Building Block

BTL – BACnet Testing Laboratories

CAV – Constant Air Volume

CCO – Contractor's Check Out

COV – Change of Value

CUH – Cabinet Unit Heater

DDC – Direct Digital Control

DLN – Device Level Network

EEPROM – Electronically Erasable Programmable Read-Only Memory

EPROM – Erasable Programmable Read-Only Memory

FAC LAN – Facility Local Area Network

FCU – Fan Coil Unit

GB – Gigabyte

HVAC – Heating Ventilation and Air Conditioning

I/O – Input / Output

IAS – Internet Authentication Service

IP – Internet Protocol

JACE – Java Application Control Engine

LAN – Local Area Network

MAU – Makeup Air Unit

MSTP – Master-Slave/Token Passing

NC – Network Controller

O&M – Operation and Maintenance

PCU – Programmable Control Unit

PIC – Protocol Implementation Conformance

PID – Proportional, Integral, Derivative

PROM – Programmable Read-Only Memory

RAM – Random Access Memory

RCD – Remote Communication Device

RH – Relative Humidity

RTU – Rooftop Unit

SAML – Security Assertion Markup Language

SD – Smart Device

SRAM – Static Random Access Memory

TCP – Technical Certification Program

UDP – User Datagram Protocol

UPS – Uninterrupted Power Supply

VAC – Volts Alternating Current

VAV – Variable Air Volume

VDC – Volts Direct Current

VPN – Virtual Private Network

WLN – Wide Area Network

1.4 SCOPE OF WORK

A. This project requires the expansion of an existing Building Automation System constructed using the Trane Tracer Framework with BACnet Field Level Devices.

B. It is the Owner's intent to purchase an open system capable of being serviced and expanded by

C. The system shall be accessible through an existing remote accessed browser based operator workstation.

D. Any and all changes occurring to the existing BAS systems in the facilities shall be coordinated with the Owner.

E. All installations near any existing controllers shall be reviewed with the Owner and Planning/Design team to ensure that the installation corresponds with future planning and upgrades.

F. The BAS Contractor is responsible for the repair of all finished surfaces effected as a result of BAS related installation work. This includes, but is not limited to, carpet, drywall, paint, ceiling tiles, furniture, and the like.

G. The Owner shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job-specific software code, databases, and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NC(s), Server(s), PCU(s) and ASC(s). Any and all required passphrases, usernames, and passwords for admin and programming level access to any component or software program shall be provided to the Owner.

H. The BAS Contractor shall provide all documents called out in these specifications including, but not limited to, submittals, O&M manuals, commissioning submittals, CAD based as-built documentation, and training manuals. Provide electronic files on secure electronic media or secure file sharing service.

I. The BAS Contractor is responsible for training facility personnel on the operation and maintenance of the system.

J. The Contractor will be required to perform the following:

1. Furnish, install, configure, and commission new programmable and application specific DDC controllers for the equipment identified in the BAS drawings, including all components, software, and applications required to meet the sequence of operation and the design/performance intent of the systems; Air Handling Units (AHUs), Rooftop Units (RTUs), Boilers, Variable Air Volume Units (VAVs), Cabinet Unit Heaters (CUHs), Fan Coil Units (FCUs), etc.

2. Provide Application Specific Controllers (ASCs) and Programmable Control Units (PCUs) as specified herein and as indicated on the BAS drawings. Provide I/O and ancillary devices as specified herein, as indicated on the BAS drawings, and as necessary to perform the sequences of operation.

3. Furnish and install all low voltage step-down transformers with associated low voltage connections, power supplies, and power/communication/input/output cabling necessary for the control system.

4. Furnish and install conduit, junction boxes, fittings, panels, enclosures, and hardware as specified in these specifications, on the drawings, and as required by Code. The Network Controllers shall be install in a cabinet in a secure area inaccessible to the general public.

5. Furnish and install all wiring required for a complete system, including communication bus, analog points, digital points, low voltage power, emergency power, and spare communication bus. Splices are not permitted within the BAS LAN or BACnet communication cables. Only continuous bus topologies, MS/TP, or continuous homeruns are allowed for these networks. Capacity of any bus shall be limited to 80% of the allowable device count to allow for future minor modifications or expansions to the network.

6. Provide system point-to-point check out, verification, and documentation. The BAS contractor shall assist Commissioning agent when applicable and/or a Test and Balance Firm in verification and functional performance testing and graphics acceptance testing.

K. It is the intent of the Owner to maintain strict standards for configuration, graphics, trends, alarms, devices, and points for the entire BAS. Please reference any and all Owner standards provided as part of the bid package and project.

L. It is the contractor's responsibility to review all of the design documents and specifications and report any discrepancies to the Engineer or Owner.

1.5 DIVISION OF WORK

A. General

1. Certain BACnet products, systems, and interface devices may be provided by other trades. Examine the Contract Documents to ascertain the requirements to install, wire, program, commission, and/or interface to these systems. Particular attention must be paid towards the interface boards submitted by the various equipment providers. It is the Contractor's responsibility to verify the submitted interfaces will integrate properly into the BAS. Report any discrepancies to the Owner.

2. Wherever work interconnects with work of other trades, coordinate with other trades and with the Owner to ensure that all trades have the information necessary so that they may properly install all the necessary connections and equipment to ensure a fully functioning and complete BAS.

B. Building Automation System (BAS) Contractor Responsibilities:

1. The BAS Contractor will provide a fully integrated and fully programmable BACnet building automation system (BAS), UL listed (UL916 and UL864), incorporating direct digital control (DDC) for energy management, equipment monitoring, and control. A UL864 listing shall be required for all controllers that are utilized in a smoke control sequence and as necessary to meet or exceed all national and local codes. In addition, UL864 devices and non-UL864 shall not be permitted on the same network segment unless the devices are separated with a UL864 Ethernet switch. All MS/TP network segments shall be consistent with its UL864 or non-UL864 implementation. Coordinate closely with the Construction Manager and Engineer the portions of the BAS system that will require UL864 listing.

2. The BAS Contractor will provide all required devices, sensors, wiring, programming, setup, and alarms for all inputs identified in the specification. The BAS Contractor shall include all hardware, software, and programming not specifically itemized in these specifications, which is necessary to implement, maintain, operate, and diagnose the system in compliance with these specifications and which is necessary to provide a complete and operable DDC system.

3. The BAS Contractor shall be responsible for all electrical work associated with the BAS control system and as called for on the Drawings, including all 120V devices not specifically called for on the Electrical Drawings which are required for a complete BAS system. This BAS control wiring shall be furnished and installed in accordance with the Electrical requirements as specified in Division 26, the National Electric Code, and all applicable local codes.

4. The successful BAS Contractor will be responsible for providing all pertinent information to the BAS Integrator, including the BACnet object listings per panel, all intrinsic or algorithmic alarm settings, all trend log information, a detailed list of control points, all setpoints, and all point ranges. The work performed by the BAS Integrator does not alleviate the BAS Contractor's responsibility to provide BACnet alarming or trending functionality. The successful BAS Contractor must support all facets of interoperability as identified in the BACnet conformance section.
5. Provide custom graphic displays, complete alarm and event management, and standardized trending for new HVAC systems onto the existing Server.
    a. The BAS Integrator will compile, manage, and present the data in the Owner's standard format.

C. HVAC Contractor Responsibilities:
1. The HVAC Contractor shall provide all wells and openings for water and air monitoring devices. Temperature sensors, flow switches, and alarms furnished by BAS Contractor.

D. Electrical Contractor Responsibilities:
1. The Electrical Contractor shall provide dedicated 120 volt, 20 amp circuits, and circuit breakers from emergency power panel for each required DDC Controller. Run power circuit to junction box near controllers installed and/or as final connection to controllers shown on Electrical Drawings by BAS Contractor.
2. The Electrical contractor will also provide smoke detector and smoke damper interlock and power wiring for all life safety applications.

E. The demarcation of work and responsibilities between the BAS Contractor and other related trades shall be as outlined in the Responsibility Matrix herein. This matrix is not intended to relieve the HVAC Contractor of the obligation to assure the complete execution of any work for which responsibility is assigned to the BAS Contractor, when the BAS Contractor is a sub-contractor to the HVAC Contractor.
1. Key:
    a. BAS = Building Automation System Contractor
    b. P = Plumbing Contractor
    c. H = HVAC Contractor
    d. E = Electrical Contractor
    e. EP = Power for the device controls is provided by means internal to the device. Control power is provided from the power circuit to the device, which is the responsibility of the Electrical Contractor.
    f. Wiring Note: Power wiring by "BAS" indicates that the BAS Contractor is responsible for extending power from a junction box or source, which has been provided by the Electrical Contractor, to a device or through a transformer to low voltage system. Transformer is to be provided by the BAS Contractor.

Responsibility Matrix					
	Work	**Furnish**	**Install**	**Low Volt. Wiring/Tube**	**Line Power**
1	BAS Low Voltage and Communication Wiring*[1] (Note 1)	BAS	BAS	BAS	N/A
2	VAV Box Controller (Note 2)	BAS	H*[2]	BAS	E
3	BAS Conduits, Raceway, Wiring, Enclosures, and Panels	BAS	BAS	BAS	BAS
4	Conduit Sleeves for BAS Penetrations thru Masonry, Concrete Walls/Floors, Etc.	BAS	BAS	N/A	N/A
5	Automatic Dampers (Non Factory)	BAS	H	N/A	N/A
6	Automatic Valves	BAS	H	BAS	N/A
7	VAV Boxes	H	H	N/A	N/A
8	DDC Controllers	BAS	BAS	BAS	E
9	Pipe Insertion Devices and Taps Including Thermowells, Flow and Pressure Stations.	BAS	H	BAS	BAS
10	BAS Current Switches.	BAS	BAS	BAS	N/A
11	BAS Control Relays	BAS	BAS	BAS	N/A
12	Power Distribution System Monitoring Interfaces	E	E	BAS	E
13	Concrete and/or Inertia Equipment Pads and Seismic Bracing	H	H	N/A	N/A
14	BAS Interface with Chiller Controls	BAS	BAS	BAS	BAS
15	Chiller Controls Interface with BAS	H	H	BAS	E
16	Elect. Baseboard Heating Control (Note 3)	H	E*[3]	N/A*[3]	E
17	All BAS Nodes, Equipment, Housings, Enclosures and Panels.	BAS	BAS	BAS	BAS
18	Smoke Detectors (Note 4)	E	E	E/ BAS *[4]	E
19	Fire/Smoke Dampers (Note 5)	H	H	BAS*[5]	E
20	Fire Dampers	H	H	N/A	N/A
21	Chiller Flow Switches	H	H	BAS	N/A
22	Boiler Wiring	H	H	H	H
23	Water Treatment System	H	H	H	E
24	Variable Frequency Drives	BAS	E	BAS	E
25	Refrigerant Monitors	BAS	BAS	BAS	E

Responsibility Matrix					
	Work	**Furnish**	**Install**	**Low Volt. Wiring/Tube**	**Line Power**
26	Computer Room A/C Unit Field-Mounted Controls	H	H	BAS	E
27	Fire Alarm Shutdown Relay Interlock Wiring	E	E	E	E
28	Fire Alarm Smoke Control Relay Interlock Wiring	E	E	BAS	E
29	Fireman's Smoke Control Override Panel	E	E	E	E
30	Fan Coil Unit Controls	BAS	BAS	BAS	E
31	Cabinet/Unit Heater Controls (Note 6)	BAS/ H*[6]	E/ BAS*[6]	BAS	E
32	Packaged RTU Space Mounted Controls	H	BAS	BAS	E
33	Packaged RTU Factory-Mounted Controls	H	H	BAS	E
34	Packaged RTU Field-Mounted Controls	BAS	BAS	BAS	E
35	Cooling Tower Vibration Switches	H	H	E	E
36	Cooling Tower Level Control Devices	H	H	E	E
37	Cooling Tower Makeup Water Control Devices	H	H	E	E
38	Starters, HOA Switches	E	E	N/A	E
39	Control Damper Actuators	BAS	BAS	BAS	E
40	LV Lighting Control Relays and Switches	E	E	E	E
41	Addressable Lighting Control Modules and Panels	E	E	E	E
42	Photo and Occupancy Sensors	E	E	E	E
43	Operable Lighting Breaker Panels	E	E	E	E

Footnotes:

*1. BAS low voltage and communications wiring: BAS Ethernet communications cable and IP infrastructure furnish and install by BAS Contractor or Division 26 Electrical Contractor as per options in Row #1 of the BAS Responsibility Matrix above.

*2. VAV box controller factory installation would normally be by Division 23 Mechanical who furnishes the VAV boxes; could be by BAS for field installation of special controllers, see Row #2 of the BAS Responsibility Matrix above.

*3. Electric Baseboard Heating Controls – for line voltage stand-alone controls: furnished by Division 23 Mechanical Contractor who furnishes the baseboard units; line voltage controls installed and connected by Division 26 Electrical Contractor. Alternately, controls may be furnished and installed by BAS Contractors for projects requiring Baseboard Heating controls to be integrated into the BAS.

*4. Smoke Detector also wired to shut down AHU/HVAC by BAS Contractor. Duct smoke detectors and fire alarm control modules shall be provided by others. Provide wiring, conduit, and necessary interface with fire alarm system to perform specified sequence of operation.

*5. Fire/Smoke Dampers: BAS Contractor to provide and ensure OPEN/CLOSE control of Fire/Smoke dampers as coordinated between BAS HVAC systems sequences, controls and overrides, and the Fire Alarm system control status priorities and overrides. Coordinate with Division 26 to provide duct detectors or fire alarm control modules for air handling unit and exhaust system shutdown and smoke control inputs to the DDC system. In most cases fire alarm control modules will be the most effective and flexible way of achieving this interface. Ensure that the logic matrix for the fire alarm devices to trigger a HVAC response is clearly specified.

*6. Cabinet/Unit Heater Controls – for line voltage stand-alone controls: furnished by Division 23 Mechanical Contractor who furnishes the Cabinet/Unit Heaters; line voltage stand-alone controls installed and connected by Division 26 Electrical Contractor.

1.6 SEQUENCES OF OPERATION

A. Program each Network Controller, ASC, PCU, device, etc., to perform the sequences of operation provided on the construction documents. Provide all necessary hardware on each piece of equipment in order for the equipment to perform the specified sequence and to meet the requirements of the point lists.

B. The Contractor shall be responsible for all control wiring connections, auxiliary devices, and control wiring diagrams to complete the control system and attain the described sequence of operation.

1.7 QUALITY ASSURANCE

A. Installer's Qualifications: The Contractor shall be fully certified and have a successful history in the design, installation, and customization of Integrated Building Automation Systems to provide monitoring and control of field level devices. Contractor must demonstrate experience in BAS installations for not less than 3 years and in DDC installation projects with point counts equal to this Project and systems of the same character as this Project.

B. Installer's Experience with Proposed Product Line: Firms shall be specialized in and be experienced with the installation of the proposed product line for not less than one year from date of final completion on at least three (3) projects of similar size and complexity. Submittals shall document this experience with references..

C. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer’s latest standard design that complies with the specification requirements.

D. The BAS must be supplied and installed by the same Control Contractor. Only Factory Authorized Distributors will be considered for installation. The letting of separate contracts by the prime HVAC Contractor for the Control System and a separate contract for its installation by a third party installer is strictly prohibited.

E. Design and build all system components to be fault-tolerant.

1. Satisfactory operation without damage at 110% and 85% of rated voltage and at plus 3-Hertz variation in line frequency.

2. Static, transient, and short-circuit protection on all inputs and outputs.

3. Protect communication lines against incorrect wiring, static transients, and induced magnetic interference.

4. Network-connected devices to be AC-coupled or equivalent so that any single device failure will not disrupt or halt network communication.

5. All Building / System Controllers shall have real time clocks and data file RAM with battery and SRAM backup.

6. All controllers shall be EEPROM, flash driven.

F. The BAS Contractor shall have a competent and factory certified Project Manager who is able to answer field questions, is aware of all schedules and schedule changes, and is responsible for the BAS Contractor's work and the coordination of their work with all other trades. This Project Manager shall be available on-site and shall respond to design, programming, and equipment related questions. Failure to provide the above services shall be considered a breach of Contract Documents.

G. Codes and Standards:

1. Comply with all current codes, ordinances, regulations, and Owner requirements.

2. All microprocessor based control products used shall conform to BTL Certified Standards, and/or Niagara 4 Framework.

3. All electronic equipment shall conform to the requirements of FCC Regulations, Part 15, Subpart B, Class A, governing radio frequency electromagnetic interference, and be so labeled.

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

5. BAS shall comply with and be listed at time of bid for the following Underwriters Laboratories Standards:

a. UL 916 for Energy Management Equipment, per category PAZX for Energy Management Equipment.

b. UL 864 for Control Units for Fire-Protective Signaling Systems, per category UUKL for Smoke Control System Equipment.

6. Comply with ASHRAE 135 for DDC system components.

a. Product shall be ISO 9001 Registered at the time of bid.

7. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

1.8 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals per requirements of Section 23 01 10.

C. Record Drawings:

1. Provide record drawings per the requirements of Section 23 01 10.

2. Provide record copies of product data and control Shop Drawings updated to reflect the final installed condition.

3. Accurately record actual set points, settings of controls, and final sequence of operation, including changes to programs made after submission and approval of Shop Drawings and including changes to programs made during specified testing.

4. Record copies shall include individual floor plans with device (controllers, routers, sensors, etc.) locations and all interconnecting wiring routing, including space sensors, LAN wiring, power wiring, and low voltage power wiring.

D. Product Data:

1. Submit manufacturer's technical product data for each Network Controller, control device, sensor, actuator, relay, panel, and accessory furnished, indicating dimensions, capacities, performance and electrical characteristics, and material finishes. Also include installation and start-up instructions.

2. As part of the submittal, provide an accurate parts list including manufacturer, model number, and quantity for all hardware and software.

a. Submit documentation indicating NICs and/or BTL compliance and include Protocol Implementation Conformance (PIC) Statements.

3. Submit Shop Drawings for each control system.

a. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.

b. Wiring diagrams showing power, signal, and control wiring.

c. Details of control panel faces including controls, instruments, and labeling.

1). Schedule of valves including flow characteristics.

d. Schedule of control dampers including performance characteristics.

4. Control Logic Documentation:

a. Provide a written description of each control sequence.

b. Include control response, settings, set points, throttling ranges, gains, reset schedules, adjustable parameters and limits as part of as-built documentation.

E. Submit a BAS Start-Up Test Agenda and Schedule for review and approval.

1.9 SYSTEM ARCHITECTURE

A. The system provided shall incorporate hardware and software resources sufficient to meet the functional requirements of these Specifications. The Facility Local Area Network (FAC LAN) and Device Level Network (DLN) shall be based on industry standard open platforms as specified herein and utilize commonly available operation, management, and application software. All software packages and databases shall be licensed to the Owner to allow unrestricted maintenance and operation of the BAS. Contractor shall include all items not specifically itemized in these Specifications that are necessary to implement, maintain, and operate the system in compliance with the functional intent of these Specifications.

B. The system architecture shall expand on the existing or implement a new building BAS which is based on the and consists of an Ethernet-based, wide area network (WAN), a single Local Area Network (LAN) that supports NCs, PCUs, ASCs, Operator Workstations (OWS), Smart Devices (SD), and Remote Communication Devices (RCDs) as applicable.

1. WAN: The WAN shall be an Internet-based network connecting multiple facilities with a central data warehouse and server, accessible via standard web-browser. This is an existing infrastructure and Contractor is not required to configure any components of this WAN. (Owner Provided and Managed)

2. Facility Local Area Network (FAC LAN): The FAC LAN shall be an Ethernet-based, 10/100/1000 Ethernet LAN connecting Local NCs, IAS Server, and OWSs. The FAC LAN serves as the backbone for the NCs communications path and as the connection point to the WAN. LAN shall be IEEE 802.3 Ethernet over Fiber or Category 6 cable with switches and routers that support 1000base-T gigabit Ethernet throughput. (Owner Provided and Managed)

3. Device Level Network (DLN): The DLN shall be a network used to connect PCUs and ASCs. These shall be IP or MSTP devices as defined in the BACnet BTL standard. Network speed shall be a minimum of 38.4K BACnet MSTP.

4. ARCnet and/or Token-Ring based FAC LANs and DLNs shall **NOT** be acceptable.

C. Remote Data Access: The system shall support Browser-based remote access to the building data. The BAS contractor shall coordinate with the Owner's IT department to ensure all remote browser access (if desired by the Owner) is protected with the latest Niagara 4 Software updates and a VPN (Virtual Private Network) which is Owner provided and managed.

D. Browser-based access: A remote/local user using a standard browser will be able to access all control system facilities and graphics via a SAML authenticated connection. Only native Internet browser-based user interfaces that do not require plug-ins (thin clients) are acceptable. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Microsoft Edge™, Firefox™, or Chrome™.

E. The communication speed between the controllers, LAN interface devices, servers, and operator interface devices shall be sufficient to ensure fast system response time under any loading condition.

F. Systems Configuration Database: The system architecture shall support maintaining the systems configuration database on a server that resides on the FAC LAN. User tools for DLN and FAC LAN management shall be provided and licensed to the Owner and shall allow unrestricted configuring, updating, maintaining, and expanding of all current devices, configurations, and settings.

G. Database Schema shall be published and provided to the Owner to facilitate easy access to DLN and FAC LAN data.

1.10 BACNET CONFORMANCE AND COMMUNICATIONS

A. All installations shall be BACnet for each level of new controller that is installed. Each controller shall be "native" BACnet in that there should be no converters from proprietary to BACnet language outside of the controller.

B. The Building Automation System (BAS) contractor shall supply a BACnet (ANSI/ASHRAE 135-2004) compliant system. Each device category and its required compliance are listed below. BACnet compatible systems that employ the use of proprietary 'gateways' will not be accepted unless otherwise noted.

C. All BACnet installations using BACnet/IP Broadcast Management Device (BBMD) for their area subnet applications shall follow these standards. This BBMD shall come from a newly supplied BBMD controller specifically included in the new installation for that newly created subnet. The BBMD shall be a controller which is a zero node controller (containing no physical I/O points) solely installed and maintained in the subnet for routing all BACnet traffic for the entire subnet.

D. All BACnet installations, including 3rd party equipment, shall be managed by one of the Owner approved BAS Contractors or by deviation request. It is the requirement of the BAS Contractor to provide BACnet Instance ID numbers and Network numbers that are appropriate within their assigned range. All third party equipment shall be integrated with BACnet. This may be done MS/TP or TCP/IP where it makes sense to implement either. In the event that BACnet is not available with the third party equipment, it may be implemented in Modbus RTU or TCP as appropriate.

E. All controllers shall be BACnet IP or MS/TP. They shall not operate on proprietary languages.

F. MS/TP controllers from the approved BAS vendors may not be intermixed on MS/TP networks. All controllers installed must be accessible from the front end software for controller level changes, such as programming, schedules, point database management, etc.

G. "Enhanced" BACnet MS/TP schemes may be used as long as the information leaving the "proprietary system" on the IP level may be accessed as BACnet compliant traffic that may be received and used by other systems.

H. The Network numbers and Instance ID's are to be managed by the BAS Contractor and an updated vendor specific spreadsheet must be submitted to the Owner with all of the vendor's Instance ID numbers whenever an addition or change is made to existing BACnet system.

I. Each control system manufacturer shall operate on their own BACnet UDP Port:

1. Tridium 47808
2. Delta 47809
3. Siemens 47810
4. Johnson Controls 47811
5. Trane 47812
6. Honeywell 47813
7. Distech 47814

J. The BACnet system shall be capable of Internet Protocol (IP) communications. BACnet/IP or Annex J will be considered the basis of design.

K. The primary Local Area Network (LAN) shall be based upon the ISO 8802-3 Ethernet standard and will be required for all Network Controllers and System Controllers. The use of MS/TP communications for interconnecting the said devices is strictly prohibited. The installation of all Ethernet wiring, accessories, and connectors shall conform to the ISO standard and/or guidelines identified herein. The connection media shall be Category 6A, Unshielded Twisted Pair (UTP) wire. The maximum single network run shall not exceed more than 90 meters. The BAS system may utilize the customer's Local Area Network (LAN) provided the bandwidth consumption is less than 10% of the total network bandwidth. Under no circumstances, shall the customer's LAN be subject to failure and/or abuse. In efforts to decrease liability, all BACnet devices that reside on the LAN must support the BACnet Broadcast Management Device (BBMD) scheme. Multi-casting or Global broadcasting will not be permitted without the use of a BBMD. The BAS Integrator has provided the BBMD device for every building. The BAS Contractor shall coordinate with the Owner and the BAS Integrator for their controllers to reside on the building level network supported by the BBMD. The Owner's network has been segmented so that each building will be a separate subnet from all others.

L. The secondary or sub-network shall utilize the Master-Slave/Token-Passing protocol, as acknowledged by the ANSI/ASHRAE 135 standard. Proprietary RS-485 or equivalent links will not be considered unless otherwise noted. The MS/TP link shall operate at a 76.8 Kbps minimum and utilize no more than 2 repeaters in any instance. Multi-channel repeaters will not be permitted.

M. The use of proprietary gateways to transmit input/output data and/or related information must reside on the Ethernet LAN and be approved, in writing, prior to the bid.

N. Network Controller Conformance: The new network controllers must be certified and listed by BTL (BACnet Testing Laboratory) under Device Profile B-BC (Annex L of the BACnet standard).

O. Advanced Application Controller Conformance (AAC): The new AAC's must be certified and listed by BTL (BACnet Testing Laboratory) under Device Profile B-AAC (Annex L of the BACnet standard).

P. Application Specific Controllers Conformance (ASC): The new ASC's must be certified and listed by BTL (BACnet Testing Laboratory) under Device Profile B-ASC (Annex L of the BACnet standard).

Q. Read / Write Properties: The entire BACnet BAS system (all OWS, Network Controllers, AAC, and ASC devices) shall support the Read/Write properties within the given BACnet objects necessary for proper operation, and shall permit dynamic creation and deletion thereof.

1.11 SUBSTITUTIONS

A. Wherever the words "for review" or "for acceptance" are used in regard to manufactured specialties, or wherever it is desired to substitute a different make or type of apparatus for that specified, submit all information pertinent to the adequacy and adaptability of the proposed apparatus to the Owner and secure their approval before the apparatus is ordered. Refer to general condition requirements for substitutions.

1.12 PRODUCT DELIVERY, STORAGE, HANDLING, PROTECTION, AND CLEANING

A. All products and materials shall be new, clean, and free of defects, damage, and corrosion.

B. Ship and store products and materials in a manner which will protect them from damage, weather, and entry of debris until final acceptance.

C. Where control devices are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

1.13 WARRANTY

A. The entire BAS and all ancillary equipment required for its operation shall be free from defects in workmanship and material under normal use and service. If within 12 months from the date of substantial completion the installed equipment is found to be defective in operation, workmanship, or materials, the Contractor shall replace, repair, or adjust the defect at no cost to the Owner.

B. The warranty period for work and systems of this project shall commence after written notification of Owner's final acceptance.

C. Corrective software modifications made during warranty service periods shall be updated on all user documentation and on user and manufacturer archived software disks.

D. The Owner reserves the right to make changes to the BAS during the Warranty Period. Such changes do not constitute a waiver of warranty. Contractor shall warrant parts and installation work regardless of any such changes made by Owner, unless the Contractor provides clear and convincing evidence that a specific problem is the result of such changes to the BAS.

E. At no cost to the Owner, during the Warranty Period, Contractor shall provide maintenance services for software including all current software updates, firmware, and hardware products. Prior to the closeout of the warranty period, the BAS contractor shall meet with the Owner's representative to address any questions or concerns and offer ongoing Software Maintenance Services to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state, and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Materials shall be new, the best of their respective kinds without imperfections or blemishes, and shall not be damaged in any way. Used equipment shall not be used in any way for the permanent installation except where Drawings or Specifications specifically allow existing materials to remain in place.

C. The Contractor shall furnish and install single controllers with the physical and software resource count for standalone operation of each piece of equipment (e.g. AHU, RTU, Plants, VAV, etc.). The sequence of operation and required points for control shall reside on a single controller. Remote I/O modules or Expansion I/O modules plugged directly into the controller may be utilized for expansion.

2.2 UNIFORMITY

A. To the extent practical, all equipment of the same type serving the same function shall be identical and from the same manufacturer

2.3 ACCEPTABLE MANUFACTURERS

A. BAS Server Software

1. Trane Tracer

B. Network Controllers

1. Trane

C. Advanced Application Controllers and Application Specific Controllers

1. Trane

2.4 BAS SERVER SOFTWARE

A. Platform Requirements

1. Hardware

a. Dual or Quad Core x64 Processor (Quad Core Xeon or better preferred for Web Sup)

b. 8GB Ram

c. 20 GB HDD

d. 1080p Display

e. 10/100 MD Ethernet Card

2. Operating System

a. Windows 10 (64 bit)

b. Windows Server 2016

c. Windows Server 2019 (64 bit)

d. Red Hat Linux Enterprise 7.7 or 8.1 (64 bit)

3. Browser

a. Chrome, Firefox, or Microsoft Edge

4. Database

a. MySQL 5.7, 8.0, 9.0

b. Oracle Express 11g

c. Oracle 12, 18, 19c

d. MSSQL 2012, 2016, 2017, 2019

2.5 NETWORKING COMMUNICATIONS

A. The design of the BAS network shall integrate stand-alone DDC Controllers on a peer-to-peer communications network, and other devices on other networks. The network architecture shall consist of the following levels:

1. A facility-wide Ethernet communications network based on the BACnet/IP protocol (Annex J.)

2. A building-wide peer-to-peer communications network between Network Controllers utilizing the BACnet protocol over Ethernet. If this specification requirement cannot be met, the manufacturer must identify how building-wide peer-to-peer communication will occur and how it will affect the Owner's IT infrastructure.

3. BACnet MS/TP secondary networks extended from appropriate Network Controllers to associated Advanced Application Controllers.

4. Any use of a proprietary network within a building operation must be identified at the time of bid as an exception to the specification.

B. Access to system data shall not be restricted by the hardware configuration of the building automation system. The hardware configuration of the BAS network shall be totally transparent to the user when accessing data or developing control programs.

C. Facility-wide Ethernet Communications Network (Primary Connection)

1. Provide a new or extend from an existing Ethernet link for the building-wide peer-to-peer network (Network Controller network). Only one peer-to-peer Network Controller per floor or area shall provide the interface to the BACnet/IP virtual network for remote monitor, remote manual control, remote alarm, and remote programming of sequences of any and all building-wide points (BBMD device).

2. All Ethernet communications shall include software management and control for both access and privilege. This shall manage all rights for access and privilege per each remote location, for remote monitor, remote manual control, remote alarm, and remote programming of sequences of any and all building-wide points.

D. Building-wide Peer-to-Peer Communications Network:

1. Network Controllers shall directly reside on an Ethernet network such that communications may be executed directly between Network Controllers and workstations on a peer-to-peer basis, without requirement for any device to operate or manage the network. A portion of the network management is built into each of the peer-to-peer members. 'Peer-to-peer' refers to controllers that (when interconnected) will act independently as equals, without a network manager, and will communicate in a token passing protocol with each other to pass data packet information for the purpose of building-wide monitoring and control. A special data packet called the 'token' is constantly and continually 'passed' to every member of the peer-to-peer communications network. Any peer-to-peer device on the network can send a packet of data only when it has the token. Any peer-to-peer device on this network can request data from, or send data to, any other device on the network. With this procedure, token ensures that data collisions do not occur, and assures that all members of the network get equal opportunity for all data on the network.

2. Systems that operate via polled response or other types of protocols that rely on a network manager, file server, or similar device to manage panel-to-panel communications will not be considered.

3. All operator devices either resident on the peer-to-peer network or connected via dial-up modems shall have the ability to access all point status and application report data or execute control functions for any and all other devices via the peer-to-peer network. Access to data shall be based upon logical identification of building equipment. No hardware or software limits shall be imposed on the number of devices with global access to the peer-to-peer network data.

4. Network design shall include the following provisions:

   a. Provide high-speed data transfer rates for alarm reporting, quick report generation from multiple controllers and upload/download efficiency between network devices. System performance shall ensure that an alarm occurring at any DDC Controller is displayed at workstations and/or alarm printers within 5 seconds.

   b. Support of any combination of DDC Controllers directly connected to the peer-to-peer network. A minimum of 50 devices shall be supported on a single network (including MS/TP).

   c. Message and alarm buffering to prevent information from being lost.

   d. Error detection, correction and retransmission shall be included to guarantee data integrity.

   e. Synchronization of real-time clocks to include automatic daylight savings time updating between all controllers shall be provided. Universal Time Coordinate based upon Greenwich Mean Time must be supported. (All Network Controller devices must have Real Time Clocks with battery and SRAM backup.

5. Acceptable protocols for intercommunications between building-wide peer-to-peer Network Controllers:

   a. BACnet over Ethernet. If this protocol is not available, then the BAS manufacturer shall identify how building-wide peer-to-peer intercommunication will occur.

E. Local Area (communications) Network (LAN):

1. This communications network shall be limited to Network Controllers and Advanced Application Controllers and shall communicate bi-directionally with the BACnet peer-to-peer network.

2. Advanced Application Controllers shall be arranged on the LAN's in a functional relationship to the corresponding Network Controllers. For example, a VAV Advanced Application Controller serving a VAV terminal box shall be connected on a MS/TP network from the Network Controller that is controlling the corresponding air handling unit.

3. A maximum of 64 Advanced Application Controllers may be configured on any individual LAN from any Network Controller to ensure adequate global data and alarm response times.

4. Acceptable protocols for intercommunications between Advanced Application Controllers and Network Controllers, are as follows:

   a. BACnet (MS/TP) or BACnet over Ethernet

5. The BAS manufacturer's control components shall not communicate on a proprietary communication network at any level. Any proprietary communication network required for third party control component shall submit to the Engineer and Owner for approval prior to purchase of the component.

2.6 PERFORMANCE SPEED REQUIREMENTS

A. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.

B. Object Scan: Transmit change of state and change of analog values to control units or workstations within six seconds.

C. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.

2.7 OPERATOR WORKSTATIONS

A. Acceptable Manufacturers

1. Subject to compliance with requirements, provide operator's front end terminals as manufactured by one of the following:

a. Dell

b. Hewlett Packard

c. Acer

d. Gateway

e. Lenovo

f. Sony

g. Others, as approved by Engineer

B. Workstations

1. Provide a PC for the BAS Server database. Minimum requirements and accessories shall be:

a. Processor: Intel "i5" series or AMD equal

b. 3GHz processor speed minimum 6M cache

c. 4GB Ram, Dual Channel, DDR3 SDRam at 1333MHz minimum

d. 16x R/W CD and DVD

e. Dual 500GB Hard disk space, 7200RPM to support RAID 1 configuration

f. USB Ports

g. NIC Card

h. 101 key enhanced keyboard, Mouse, power strip

i. UPS for 15 minute backup

2. Provide an active matrix LCD, flat panel type monitor that supports a minimum display resolution of no less than 1600 × 1200 pixels, Energy Star compliant. The display shall have a minimum of 24-inch visible area in diagonal measurement. Separate controls shall be provided for color, contrasts and brightness. The screen shall be non-reflective.

3. Printer 1: Provide a compatible laser printer for printing of dynamic trend graph reports, Excel reports, graphics and any other screen displays.. Provide drivers.

4. Printer 2: Provide a color printer for printing of alarms, operator transactions and system reports. Printer shall be an Epson 890 or equivalent. Provide drivers.

5. Locate the BAS Server in a clean, secure, dry and temperature controlled environment.

6. Provide software licenses for interfacing to the BAS. Load software, configure and setup for viewing the BAS system.

7. Software: Provide the following application software licenses, preloaded on the Operator Workstation for the Owner: MS Office Professional, PC anywhere or terminal services, Internet Explorer or equal browser, MS Outlook, Acrobat Reader, CAD Viewer. Set up an icon on the desktop to take the Owner directly to the BAS system login page.

C. Software Requirements

1. Provide and install all required software to allow access to building automation system.

D. Commissioning Hardware/Software Requirements

1. Provide and install all required software (on laptop PC furnished by the Commissioning Agent) to allow access to building automation system.

2. Provide all required hardware to Commissioning Agent to allow direct connection to Building Automation System Controllers for the purpose of testing, trouble shooting, and tuning.

2.8 NETWORK CONTROLLERS (JACE's)

A. All Network Controllers shall have the following features:

1. ARM A8 Processor 1 GHZ
2. 1 GB DDR3 SDRAM
3. (1) micro-SD Card (4GB)
4. (2) 10/100 MB Ethernet Ports
5. (2) isolated RS-485 Ports
6. (1) USB type A
7. Power Requirements
   a. 24VAC or 24VDC
8. Real Time Clock
9. Battery-Free Design
10. Supports Optional Modules
    a. LON
    b. RS-232
    c. Additional RS-485
    d. I/O Modules

2.9 ADVANCED APPLICATION CONTROLLERS (AAC'S)

A. General: Provide an adequate number of BACnet Advanced Application Controllers to achieve the performance. Each of these panels shall meet the following requirements.

1. DDC (stand-alone) Controllers shall have a 32 bit processor with EEPROM, flash driven operating system (OS). They shall also be multi-tasking, multi-user, real-time digital control processors and permit I/O expansion for control / monitoring of up to 48 I/O. Controller size shall be sufficient to fully meet the requirements of this specification.

2. Advanced Application Controllers shall be fully peer to peer.

3. The operating system of the Controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms.

4. Each Controller shall be capable of monitoring the following types of inputs without the addition of equipment outside of the Controller cabinet:
    a. Analog inputs
        1). 4-20 mA
        2). 0-10 VDC
        3). Thermistors
    b. Digital inputs
        1). Dry contact Closure
        2). Pulse Accumulator
        3). Voltage Sensing
5. Each Controller shall be capable of providing the following control outputs without the addition of equipment outside the Controller cabinet:
    a. Analog outputs
        1). 4-20 mA
        2). 0-10 VDC
        3). 0-135 Ohm (with external Transducer)
    b. Digital outputs (contact closure)
        1). Contact Closure (Motor Starters, up to size 4)
6. Each Controller shall have a minimum of 10 percent spare capacity for future point connection and be supplied with all necessary expansion modules to utilize the spare capacity. The controller shall support up to 48 (minimum) I/O with modular expansion modules. The type of spares shall be in the same proportion as the implemented I/O functions of the panel, but in no case shall there be less than two spares of each implemented I/O type. Provide all processors, power supplies, database memory, program sequence memory, and communication controllers complete so that the implementation of any added point (within the above 10% spare) only requires the addition of the point sensor and wiring.
    a. Provide sufficient internal memory for the specified control sequences and have at least 25% of the memory available for future use.
    b. Each Controller shall provide at least one RS-232C serial data communication ports (BACnet PTP compatible) for operation of operator I/O devices such as industry standard printers, operator terminals, modems, and laptop portable operator's terminals. Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or terminals. System-wide access must be provided at each mechanical equipment room through the local Controller. Panel mounted terminals are not required.
7. Each Controller shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Controller shall provide both local and remote annunciation of any detected component failures and for repeated failure to establish network communications.
8. Controllers shall be to control pieces of equipment or systems as indicated or required for operational intent on the drawings. The use of AAC devices for critical or main system equipment will not be permitted.

9. All points associated with a given mechanical system (i.e., an air handling unit) will be controlled from a single Controller or point expansion panels from the respective controller. No points from a given mechanical system may be distributed among multiple panels - points must be run back to a single Controller dedicated to that mechanical system. Closed-loop control must never depend upon network communications. All inputs, program sequences, and outputs for any single DDC control loop shall reside in the same Controller.

10. Both firmware and controller database shall be loadable over the network.

B. Communication

1. Each Advanced Application Controller shall reside on a BACnet network using the MS/TP or Ethernet Data Link/Physical layer protocol.

2. The controller shall provide a service communication port using BACnet Data Link/Physical layer protocol for connection to portable operator's workstation and allow access to the entire network.

3. Controllers that lose communication or control due to a single sensor failure are not permitted.

C. Environment: Controller hardware shall be suitable for the anticipated ambient conditions.

1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 0°C to 40°C [32°F to 100°F].

2. Controllers used in conditioned space shall be mounted in dust proof enclosures and shall be rated for operation at 0°C to 50°C [32°F to 120°F].

D. Serviceability: Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.

1. Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated intensity LED's or analog indication of value shall also be provided for each analog output.

E. Memory: The Advanced Application Controller shall have sufficient memory to support its operating system, database, and programming requirements. The Controller shall utilize non-volatile FLASH memory to maintain its operating system and backup all operator entered changes to setpoints, schedules, and commands.

1. Each Controller shall have sufficient flash memory (EEPROM), a minimum of 2 megabyte, to support its own operating system. In addition, there shall be additional SRAM memory for database handling. Both the EEPROM and SRAM shall permit full implementation and support of all B-BC requirements of this specification, including:

a. Control processes

b. Energy management applications

c. Alarm management applications including custom alarm messages for each level alarm for each point in the system.

d. Historical/trend data for points specified

e. Maintenance support applications

f. Custom processes

g. Operator I/O

h. Dial-up communications

i. Manual override monitoring

F. Immunity to power and noise: Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to120 Hz and from keyed radios up to 5 W at 1 m [3 ft].

1. In the event of the loss of normal power, there shall be an orderly shutdown of all Controllers to prevent the loss of database or operating system software. Programs residing in memory shall be protected by using EEPROM under capacitor backup. The backup power source shall have sufficient capacity to maintain volatile memory in event of an AC power failure. Where interruptible power source is rechargeable (a rechargeable battery), provide sufficient capacity for a minimum of seventy-two hours backup. Charging circuitry, while the controller is operating under normal line power, shall constantly charge the rechargeable power source. A non-rechargeable power source shall not be permitted. Batteries shall be implemented to allow replacement without soldering.

a. Upon restoration of normal power, the Controller shall automatically resume full operation without manual intervention. If manual intervention is required upon loss of normal power, an uninterruptible power supply will be furnished within each control panel to provide a minimum of 2 hours of back-up power. This function will be field demonstrated for each controller.

2.10 APPLICATION SPECIFIC CONTROLLERS (ASC'S)

A. General: Provide BACnet Application Specific Controllers (ASCs) as required to execute the sequence of operations. ASC’s are microprocessor-based DDC controllers which through hardware or firmware design are able to control a wide variety of equipment. They shall be fully user-configurable.

1. Each ASC shall be capable of standalone operation and shall continue to provide control functions without being connected to the network.

2. Each ASC will contain sufficient I/O capacity to control the target system.

3. Both firmware and controller database shall be loadable over the network.

4. ASC’s shall come with an integrated housing to allow for easy mounting and protection of the circuit board. Only wiring terminals shall be exposed.

B. Communication

1. The controller shall reside on a BACnet network using the MS/TP or Ethernet Data Link/ Physical layer protocol.

2. Each controller shall have a BACnet Data Link/ Physical layer compatible connection for a laptop computer or a portable operator's tool. This connection shall be extended to a space temperature sensor port where shown and allow access to the entire network.

C. Environment: The hardware shall be suitable for the anticipated ambient conditions.

1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at -40°C to 65°C [40°F to 150°F] and/or suitably installed in a heated or fan cooled enclosure.

2. Controllers used in conditioned space shall be mounted in dust proof enclosures, and shall be rated for operation at 0°C to 50°C [32°F to 120°F].

D. Serviceability: Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips.

E. Memory: The Application Specific Controller shall use non-volatile memory and maintain all BIOS and programming information in the event of a power loss.

F. Immunity to power and noise: ASC shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%. Operation shall be protected against electrical noise of 5-120 Hz and from keyed radios up to 5 W at 1 m [3 ft].

G. Transformer: Power supply for the ASC must be rated at minimum of 125% of ASC power consumption and shall be fused or current limiting type.

H. Input/Output: ASC shall support as a minimum, directly connected, a combination of analog outputs and binary outputs and universal software selectable analog or digital inputs. ASC inputs shall support 0-5 VDC-voltage, 4-20mA-current, thermistor-resistance, and dry contacts. ASC outputs shall support 0-10 VDC-voltage, digital triac rated at 0.5 amps at 24 VAC.

2.11 CONTROLLER RESIDENT SOFTWARE FEATURES

A. General:

1. All necessary software to form a complete operating system as described in this specification shall be provided.

2. The software programs specified in this Section shall be provided as an integral part of Controllers and shall not be dependent upon any higher level computer for execution.

3. Point naming convention shall be per the Owner's standards. The Controller shall support a 128 character object name length. Controllers that only permit a 32 character length will not be permitted.

B. Control Software Description:

1. The Controllers shall have the ability to perform any or all of the following pre-tested control algorithms:

a. Two-position control

b. Proportional control

c. Proportional plus integral control

d. Proportional, integral, plus derivative control

2. Control software shall include a provision for limiting the number of times that each piece of equipment may be cycled within any one-hour period.

3. The system shall provide protection against excessive demand situations during startup periods by automatically introducing time delays between successive start commands to heavy electrical loads. This feature shall be resident in all Binary Output objects. The use of custom programming to prevent an excessive demand on start-up shall not be required.

4. Upon the resumption of normal power, each Controller shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operations.

C. All programs shall be executed automatically without the need for operator intervention and shall be flexible enough to allow user customization. Programs shall be applied to building equipment as described in the Sequence of Operations. Controllers shall have the ability to perform any or all of the following energy management routines:

1. Time-of-Day Scheduling

2. 365 Day Calendar-Based Scheduling

3. Holiday Scheduling

4. Temporary Schedule Overrides

5. Start-Stop Time Optimization

6. Automatic Daylight Savings Time Switch Over
7. Night Setback Control
8. Enthalpy Switch Over (Economizer)
9. Peak Demand Limiting
10. Temperature-Compensated Duty Cycling
11. Fan Speed / Control
12. Heating/Cooling Interlock

D. Controllers shall be able to execute custom, job-specific processes defined by the user to automatically perform calculations and special control routines.

1. It shall be possible to use any of the following in a custom process:
    a. Any system measured point data or status
    b. Any calculated data
    c. Any results from other processes
    d. User-defined constants
    e. Arithmetic functions (+, -, *, /, square root, exponential, etc.)
    f. Boolean logic operators (and/or, exclusive or, etc.)
    g. On-delay/off-delay/one-shot timers
2. Custom processes may be triggered based on any combination of the following:
    a. Time interval
    b. Time-of-day
    c. Date
    d. Other processes
    e. Time programming
    f. Events (e.g., point alarms)
3. A single process shall be able to incorporate measured or calculated data from any and all other controllers on the network. In addition, a single process shall be able to issue commands to points in any and all other controllers on the network.
4. Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or phone.
5. The custom control programming feature shall be compiled and documented via English language descriptors. These descriptors (comment lines) shall be viewable from local operator I/O devices to facilitate troubleshooting.

E. Alarm management shall be provided to monitor and direct alarm information to operator devices. Each Controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall the Controller's ability to report alarms be affected by either operator activity at a PC workstation, local I/O device, or communications with other panels on the network. Refer to the Owner's alarm standards.

1. The user shall be able to define the specific system reaction for each point.

2. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.

    a. Each Controller shall be capable of storing all custom alarm text for each alarm. The alarm text shall be unique and user defined; custom text shall be available for all BACnet alarms and shall reside in the Controller, not in an OWS or PC.

    b. Alarms shall have ability to be acknowledged from the local operator I/O device (once the problem is resolved).

F. A variety of historical data collection utilities shall be provided for manual or automatic sampling, storing, and displaying system data for points.

1. Controllers shall store point history data for selected analog and digital inputs and outputs:

    a. Any point, physical or calculated, may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each Controller. Two methods of collection shall be allowed either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of 1 second to 7 days shall be provided. Each Controller shall have a dedicated RAM-based buffer for trend data and shall be capable of storing a minimum of 10,000 data samples.

2. Trend data shall be stored at the Controllers and uploaded to the workstation through the BACnet web server when retrieval is desired. Uploads shall occur based upon either user-defined interval, manual command, or automatically when the trend buffers are full. Furthermore, the BACnet web server shall notify the end-user if the hard drive capacity is low or if the database size is excessive. The BACnet web server shall use a standard MSDE or SQL database handler for all trend log management. All trend data shall be available to all BACnet web servers and for use in 3rd party personal computer applications. File format type to be comma delineated.

3. Controllers shall also provide high resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms shall be provided for operator-selected PID control loops. Provide capability to view or print trend and tuning reports. (Do not initially set up any auto loop tuning algorithms.)

    a. The Loop object shall display the most recent historical data of its own performance. It shall illustrate the number of setpoint crossings and the maximum and average deviation from setpoint.

    b. Loop tuning shall be capable of being initiated either locally at the Controller, from a network workstation, or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.

4. BAS manufacturer shall provide programming time to set up standard trends and create custom reports for each Controller. The BAS Integrator shall program the existing BACnet web server to create historical trend reports for the trends set up by the BAS Contractor.

G. Controllers shall automatically accumulate and store run-time hours for digital input and output points associated with all pieces of equipment.

1. The totalization routine shall have a sampling resolution of one minute or less.

2. The user shall have the ability to define a warning limit for run-time totalization. Unique, user-specified messages shall be generated when the limit is reached.

H. Controllers shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and digital pulse input type points.

1. Totalization shall provide calculation and storage of accumulations of up to 99,999.9 units (e.g., kWh, gallons, BTU, tons, etc.).

2. The totalization routine shall have a sampling resolution of one minute or less.

3. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

I. Controllers shall have the ability to count events such as the number of times a fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, or monthly basis.

1. The event totalization feature shall be able to store the records associated with a minimum of 9,999.9 events before reset.

2. The user shall have the ability to define a warning limit. Unique, user-specified messages, up to 200 characters, shall be generated when the limit is reached.

2.12 THIRD PARTY INTERFACES

A. Manufacturer third party interfaces shall be limited to equipment which the BAS contractor cannot or has not been contracted to control directly via DDC controllers. This equipment shall include but not limited to the following: Process Controls, Generators, ATS, Energy Meters, Lighting Systems, Etc.

2.13 GRAPHICS

1. The following graphic pages shall be constructed in accordance with the Owner's graphics standards.

a. Site Home Pages for campuses or stand-alone buildings

b. Building Home Pages

c. JACE Information (Pop-up) pages for Network Controllers

d. Floor Plan pages for individual (office) areas/floors served by terminal equipment

e. System/Equipment Pages for each unique system or piece of equipment, including pop-up windows for setpoints, notes, and attachments

f. System Overview Pages for terminal equipment systems (VAVs, FCUs, etc.)

g. Integrated Equipment Pages or pop-up windows (determined by equipment type)

h. Alarm modifications

i. Trending pages and pop-up windows

j. Schedule modifications

k. Critical equipment dashboard and reports modifications

2.14 PANEL ENCLOSURES

A. Subject to compliance with requirements, provide Panel Enclosures as manufactured by one of the following:

1. Saginaw Control and Engineering

2. Siemens

3. Hoffman

4. Hubbell

5. Engineer approved equal

B. Enclosure type shall be appropriate for the mounting location, as described below.

1. Outdoor Use: Stainless Steel NEMA 4 Enclosure
2. Indoor Electrical or Control Room Use: Carbon Steel NEMA 1 Enclosure with baked enamel finish and hinged front access door with foam seals.
3. Indoor Process Area Use (Default Type): Stainless Steel NEMA 4 Enclosure

C. Panel Requirements:

1. Size panels to accommodate controllers and associated components.
2. Enclosures shall have perforated backplate for device mounting.
3. Enclosures shall have removable hinged door.
4. On the inside door of each enclosure, affix a wiring diagram complete with the following information (at a minimum):
   a. Control Panel Name
   b. Control Panel Layout, including device part numbers
   c. Wiring diagram, with each wiring terminal contained within the enclosure clearly identified by connection or noted as spare.

2.15 PANEL NAMEPLATES

A. Install an engraved micarta nameplate containing the information outlined below (at a minimum):

1. Control System Cabinet Name
2. Name of Controllers within panel
3. Power source
4. Network source (If applicable)

B. See drawings for additional requirements

2.16 CONTROL POWER SOURCE AND SUPPLY

A. BAS Contractor shall provide all power source wiring required for operation of all equipment and devices provided under Division 23 and the BAS Drawings.

B. Provide power to all controller enclosures from a J-box located in the vicinity of the panel. Connection from the J-box to the enclosure to be by the BAS Contractor. Provide a local disconnect, a 120V convenience outlet, and physical barriers between 120V and 24V wiring.

C. The Contractor shall assume responsibility for selecting the correct VA rating for each power supply to accommodate individual panel loads.

2.17 VISUAL ALARMS

A. Provide NEMA 4X strobe warning lights with amber dome color as manufactured by Federal Signal Corporation Model FB24ST, or approved equal, in locations as shown on the drawings. The strobe lights shall be supervised and shall be initiated upon ventilation system failure. The Contractor shall select the appropriate voltage and mounting accessories.

2.18 SURGE PROTECTION

A. Contractor shall furnish and install any power supply surge protection, filters, etc. as necessary for proper operation and protection of all NCs.

B. Surge transient protection shall be incorporated in design of system to protect electrical components in all Network Controllers and Advanced Application Controllers. Provide an external protection device listed under UL 1449 with minimum clamping voltage of 130 VRMS and surge current capability of 22,500 Amps for all custom fabricated control panels and all main system components (i.e., AHUs, Chillers, Boilers, etc.).

C. All equipment shall be capable of handling voltage variations 10 % above or below measured nominal value, with no effect on hardware, software, communications, and data storage.

2.19 LABELING

A. Provide labels for panel enclosures and all field devices including sensors, transducers, thermostats, and relays.

B. Labels shall be black laminated plastic and epoxy glue or screw fasteners. Labels shall be located adjacent to device and permanently affixed to device mounting surface. Labels for sensors in pipes may be secured using chain around the sensor well. Labels shall be 1/16" thick laminated plastic or 0.020" thick aluminum; black face, 3/16" high white or natural aluminum letters.

C. Identify all control wiring and air piping at each end with a wire tags or labels. Wiring to be labeled as to what the wire serves not just to identify ends of wire. In addition, use standardized color scheme for control wiring to designate type of control each wire serves.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine areas and conditions under which control systems are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

B. These specifications call out certain duties of the Contractor and any subcontractor(s). They are not intended as a material list of all items required by the Contract.

3.2 INSTALLATION

A. Utilize licensed electricians for all new and retrofitted electrical distribution systems and comply with Division 26 electrical specifications.

B. All control wiring incidental to the Temperature Control System shall be by the Temperature Control Contractor except as follows:

1. Line voltage thermostats shall be turned over to the Electrical Contractor for installation and wiring.

2. Wiring shown on the Electrical Contract Drawings shall be wired by the Electrical Contractor.

C. Provide related items and work indicated on the BAS Drawings and items and work called for in this Division of the Specifications. This includes all incidentals, equipment, appliances, services, hoisting, scaffolding, supports, tools, supervision, labor, consumable items, fees, licenses, etc., necessary to provide complete systems. Perform start up, configuration, programming, and commissioning coordination on each control product and system to provide fully operable systems in accordance with the specified functional performance.

1. All control elements shall be placed in locations affording easy access for service. All devices remote from control panels shall be identified as specified for control items in control panels.

D. All temperature control panels shall be completely prewired by the BAS Contractor to terminal strips within the control cabinet. All internal interlock wiring within the control panel shall be complete to the terminal strips.

E. All 120V and low voltage electrical control wiring exposed throughout the building and within walls shall be run in conduit in accordance with the Electrical requirements as specified in Division 26, the Owner's standards, the National Electric Code, and all applicable local codes. All wiring shall comply with specification Section 23 09 40.

F. All conduit and conduit installation, including conduit utilized for plastic pneumatic tubing, shall be in accordance with the requirements of Division 26, Electrical Specification.

G. Installation shall be in accordance with manufacturer's published recommendations and shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

H. Adjusting

1. Calibrating and Adjusting:

a. Calibrate instruments.

b. Make three-point calibration test for both linearity and accuracy for each analog instrument.

c. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.

d. Control System Inputs and Outputs:

1). Check analog inputs at 0, 50, and 100 percent span.

2). Check analog outputs using milliampere meter at 0, 50, and 100 percent output.

3). Check digital inputs using jumper wire.

4). Check digital outputs using ohmmeter to test for contact making or breaking.

5). Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

e. Flow:

1). Set differential pressure flow transmitters for 0 and 100 percent values with 3 point calibration accomplished at 50, 90, and 100 percent span.

2). Manually operate flow switches to verify that they make or break contact.

f. Pressure:

1). Calibrate pressure transmitters at 0, 50, and 100 percent of span.

2). Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

g. Temperature:

1). Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.

2). Calibrate temperature switches to make or break contacts.

h. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.

i. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.

j. Provide diagnostic and test instruments for calibration and adjustment of system.

k. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures for review and approval before initiating startup procedures.

2. Adjust initial temperature and humidity set points.

3. Occupancy Adjustments: Provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

I. The BAS Drawings show the general arrangement of the respective systems. Follow these Drawings as closely as actual building construction and the work of other trades will permit. Provide devices, power, fittings, sensors, controllers, wiring, and accessories, which may be required but are not shown on the Drawings or specified herein. The Contractor shall be responsible for achieving the sequence of operations and intent of the system design.

J. All installation shall be in accordance with manufacturer’s published recommendations.

K. Limit LAN cable lengths to no longer than 80% of the longest dimension published by the manufacturer of the cable between the most remote network nodes.

L. Comply with all rules, guidelines and procedures defined by the Owner’s IT authority.

3.3 IDENTIFICATION

A. Control Device

1. For each control device (i.e. sensor, switch, actuator, terminal strip, relay, etc.) provide and install an adhesive laminated label which clearly and uniquely identifies device.

2. Control device labeling shall be coordinated with as-built wiring diagrams, such that any device can be referenced to the wiring diagrams.

3. Include the following (as a minimum)

a. Device Identifier

b. Controlling/monitoring controller

c. Power source

B. Wiring

1. Label all Controller I/O wiring at each end (controller and device) with an identifier which clearly indicates controller and terminating point number.

C. Panel Nameplates

1. Permanently adhere nameplates on all control system cabinets.

D. Transformers

1. For each control transformer, clearly note the following

a. Power Source (including panel name, location, and circuit number)

b. Device(s) served.

3.4 NETWORK MANAGEMENT FUNCTIONAL REQUIREMENTS

A. Contractor shall thoroughly and completely configure BAS system control devices, software, supplemental software, application programming, network communications, Servers, operator workstations, printer, and network communications to permit the functional requirements of the BAS herein specified. The setup shall include as a minimum the following network management procedures:

1. Automatic backup of the BAS System database to appropriate media.

2. Program, load and debug all software installations, including integration of third party applications (e.g. analytics and energy management).

3. Network user auditing.

3.5 SITE CLEAN UP

A. At conclusion of each day's work, and at the request of the Owner, clean up and remove from the site all rubbish, debris, and trash accumulated during the day as a result of work of the Contractor.

B. Marks on walls or ceiling tiles caused by the Contractor shall be cleaned by the Contractor. Ceiling tiles, drywall, carpet, paint, and all architectural finishes damaged by the Contractor shall be replaced by the Contractor.

3.6 BAS CONTRACTOR'S CHECK OUT, START-UP TESTING, ADJUSTING, CALIBRATION

A. Field Test: When installation of the system is complete, calibrate equipment and verify transmission media operation before the system is placed on-line. The installer shall complete all testing, calibrating, adjusting, and final field tests. Verify that all systems are operable from local controls in the specified failure mode upon panel failure or loss of power. Upon completion of the work, notify the Owner and Engineer that the system is ready for final tests and inspection.

B. At the time of final inspection, this Contractor shall be represented by a person with the proper authority who shall demonstrate, as directed by the Engineer, that his work fully complies with the purpose and intent of the Specifications and Drawings. Labor, services, instruments, and tools necessary for demonstrations and tests shall be provided by the Contractor.

C. The Contractor shall test and adjust each instrument specialty and equipment furnished by him, prior to final acceptance. The Contractor shall demonstrate, for approval by the Engineer, a properly functioning, integrated system with subsystems operating as coordinated.

D. The Contractor shall furnish labor to provide adjustments and incidentals necessary to obtain the desired and intended results.

E. The Contractor shall turn over a printed copy and electronic copy of the completed and debugged operating software to the Owner at the conclusion of the warranty period.

F. Work and/or systems installed under this Division shall be fully functioning prior to Demonstration and Acceptance Phase.

G. Contractor shall conduct the CCO which addresses the start-up, testing, adjustments, and calibrations of all work and/or systems under this Contract.

H. All CCO testing procedures shall be documented in the CCO report to be provided by the contractor to the Owner.

3.7 OWNER TRAINING

A. Provide Owner Training per requirements of Section 23 02 10.

3.8 SUMMARY OF BAS ACCEPTANCE PROCEDURE

A. Submit product data, Shop Drawings, logic documentation, and sample graphics to the Engineer of Record and receive approval.

B. Obtain Owner's acceptance of each phase of installation when installation consists of a renovation in an occupied space.

C. Submit as-built record documents.

D. Provide the Owner an agenda and schedule of CCO testing activities for approval and coordination.

E. Provide written notice that the system is ready for Owner acceptance testing. Schedule BAS Demonstrations with Owner.

F. Demonstrate BAS systems to Owner and Engineer. Perform functional performance testing including sequence of operation, point to point verification to graphical interface, historical data logging, and alarms.

G. Owner to provide detailed punch list to contractor.

H. Contractor to repair issues on Owner punch list in seven (7) calendar days.

I. Contractor provides all passphrases, usernames, passwords, software, GUI, databases, licenses, and application programming tool(s) to Owner.

J. Contractor Trains Owner on all aspects of the BAS including architecture, devices, software, final sequences, and modes of operation.

K. Owner issues letter to contractor declaring that system is substantially complete. Date of this letter starts the warranty period.

L. Revise and re-submit as-built record Drawings and O&M Manuals.

M. Final Acceptance. Owner issues letter to Contractor accepting system.

END OF SECTION 23 00 00

SECTION 23 92 10
WIRE AND CABLE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Furnish material, tools, labor, and supervision necessary to install wire and cable.

1.3 STANDARDS AND CODES

A. Methods of installation shall comply with the provisions of applicable sections of NEC, Article 300.

B. Materials shall be in accordance with NEC, Article 310 and shall be UL listed for application intended.

1.4 DESCRIPTION

A. This section describes the basic materials and methods of installation for general wiring systems of 600 volts and less. Wiring for a higher voltage rating, if required, shall be as specified in other sections or as called for on the drawings.

B. Minimum size conductors shall be No. 12 AWG for power and lighting and No. 14 AWG for signal and control.

C. Refer to Spec Section 260053 for specific instructions with respect to sizing and installation of feeder and branch circuit conductors.

1.5 QUALIFICATIONS

A. The material used for the wiring systems shall be the products of a manufacturer regularly engaged in the manufacturing of the specified material. Where a manufacturer is named for a particular material, the material of other manufacturers will be acceptable provided the material meets requirements of the Specifications.

PART 2 - PRODUCTS

2.1 WIRE AND CABLE

A. Wire and cable for power, lighting, control and signal circuits shall have copper conductors of not less than 98% conductivity and shall be insulated to 600V. Conductors shall be stranded except where specifically noted otherwise.

B. Wire and cable type for the various applications shall be as follows:

1. Type THWN or XHHW (75°C): Use for branch circuits, panel and equipment feeders in wet and dry locations.

2. Type THHN or XHHW (90°C): Use for branch circuits, panel and equipment feeders in dry locations only. Use where lighting branch circuit conductors are routed through fluorescent fixture channels.

3. Type "VFD Rated": Feeders, size #8 AWG and larger, from variable frequency drives shall be multi-conductor shielded cables with the following performance requirements.

a. Phase conductors shall be tinned copper, extra flexible 34 AWG Class M stranding (size 10 AWG and smaller) or 30 AWG Class K stranding (size 8 AWG and larger), with XLPE insulation.

b. Ground conductors shall be tinned copper, 100% rated, and symmetrically spaced (three ground cables total).

c. Shielding shall consist of 100% aluminum foil shield with 85% tinned copper braided shield (size 2 AWG and smaller) or two (2) copper tape shields with 100% coverage (size 1 AWG and larger).

d. Overall cable jacket shall be type TPE, sunlight and oil resistant, and have a tray cable exposed rating, Type TC-ER.

4. Type UF: Use where permitted by other Sections or by the drawings for underground direct burial branch circuits.

5. Type AF or SF-2 silicone rubber with heat-resistant glass braid (rated minimum 150°C) shall be used for branch circuit conductors connecting to fixture conductors within the fixture housing or to a connection box attached to the fixture and subject to temperatures equal to the temperatures within the fixture housing.

2.2 CONDUCTOR COLOR CODING AND IDENTIFICATION

A. Wiring systems shall be color coded. Conductor insulation shall be factory colored in sizes up through No. 8 AWG. Conductors No. 6 AWG and larger shall have black insulation and shall be phase color coded with one half inch band of colored tape at all junctions and terminations. Colors shall be assigned to each conductor as described below and carried throughout all main and branch circuit distribution.

	208/120 Volt	480/277 Volt
Phase 'A'	Black	Brown
Phase 'B'	Red	Orange
Phase 'C'	Blue	Yellow
Neutral	White	Gray
Equipment Ground	Green	Green
Isolated Equipment Grounding	Green w/ Yellow Stripe	

B. Contractor shall take extraordinary care to ensure that phase and bus orientation in each and every panel is identical.

C. Control wiring shall be color coded such that red is used exclusively for all 120 volt conductors and white for all neutral conductors. All control wiring to be identified at both ends with permanent wire markers.

2.3 CONNECTORS

A. Splices and junctions for conductors #8 AWG and smaller shall be 600V rated with "live spring" and insulated rigid nylon wing style body, 3M "Performance Plus", Ideal "Buchanan B-Cap", or equal.

B. In-line connectors for 600V copper conductors #6 AWG thru #3 AWG shall be ILSCO type "CT" circumferential compression sleeves or equal by 3M, Burndy, or Thomas & Betts.

C. In-line connectors for 600V copper conductors #2 AWG and larger shall be extra long barrel dual-crimp ILSCO type "CTL" compression sleeves or equal by 3M, Burndy, or Thomas & Betts.

D. Insulate in-line connectors with cold shrink silicone insulators 3M "8440" series.

E. Taps for copper conductor 600V or less, sizes No. #6 AWG and larger shall be ILSCO "AH" series or equal by 3M, Burndy, or Thomas & Betts.

F. Insulate taps to thickness of conductor insulation with half-lapped layers of 3M "Scotch" brand No. 33 vinyl electrical tape. Connectors having irregular surfaces; fill voids and smooth contours with 3M "Scotchfil" electrical putty prior to taping.

G. Where mechanical style connections are permitted, cable terminations to bus bars and switch pads shall be ILSCO "TA" two-hole mechanical or equal by 3M, Burndy, or Thomas & Betts.

H. Where compression style connections are required, cable terminations to bus bars and switch pads shall be ILSCO "CLWD" two-hole long-barrel dual-crimp compression type with sight hole or equal by 3M, Burndy, or Thomas & Betts.

1. Lugs installed in wet locations on poles or outdoors where exposed shall be furnished without sight hole, ILSCO "CLND" or equal by 3M, Burndy, or Thomas & Betts.

I. Mechanical and compression termination bolt/stud size and mounting hole spacing shall match factory bus hole size. Stacking lugs and spacers shall be provided as required for parallel cable runs.

J. Cable terminations at motors shall be bolted and removable with 1-hole copper compression lugs on the motor pigtail and feeder conductors, and motor terminal insulation kit 3M "5300" series, or equal. Motor terminal insulation kit shall include lug cover, mastic strip Scotch No. 2230, silicone grease, and Scotch No. 33 tape.

PART 3 - EXECUTION

3.1 PREPARATION

A. For new construction, wiring shall not be installed in the conduit system until the building is enclosed and masonry work is completed.

B. Conduit shall be swabbed free of moisture and debris prior to pulling in the conductors.

3.2 CONDUCTOR INSTALLATION

A. Feeder conductors shall be routed continuous from origin to destination, without splicing, unless specifically noted otherwise on the drawings.

B. Power feeder conductors shall be pulled with the use of an approved pulling compound or powder, and per the requirements of Section 260125.

C. Conductor splices shall be made only in readily accessible junction boxes.

D. Cable supports and boxes shall be installed in all vertical feeders required by Article 300.19 of the National Electrical Code. Cables shall be supported at the top of the vertical raceway plus an additional support for each interval of spacing as specified in table 300.19 (A) of the NEC. For cables without a metallic sheath, the cable support shall be of the split wedge type which clamps each individual conductor firmly and tightens due to weight of cables.

E. "VFD Rated" multi-conductor shielded cables shall be terminated according to the manufacturers recommendations. Braided shields shall be routed unbroken where service disconnects are located between the VFD and motor. Phase and ground conductors shall be pulled through braided shields at each end and terminated together with the ground conductors.

3.3 CONDUCTOR TERMINATIONS

A. Terminations materials shall be as required by the equipment manufacturer’s installation guidelines.

B. Bolt diameter shall be properly sized for the terminations, in the absence of manufacturer's installation requirements, the largest diameter shall be used.

C. Bolts shall be tightened to the torque values specific to the material, threads per inch, and nominal diameter. Bolted connections shall not be lubricated.

D. Unless stipulated otherwise, the minimum grade bolt material shall be SAE J429 Grade 5 medium carbon steel.

E. Belleville spring type washers shall be utilized for termination of conductors 350MCM and larger. Split ring lock washers shall be utilized on smaller conductor terminations.

F. Connections shall be initialed or otherwise labeled after final torquing.

3.4 CATEGORY 5e/6 TESTING

A. Each channel shall be tested as a whole. The channel shall include each cable pair, jack, and patch panel.

B. Each channel shall be tested for length, DC continuity, NEXT, PSNEXT, attenuation, return loss, ELFEXT, and PSELFEXT using tester for Category 5e/6 channel compliance.

C. Each channel shall be field tested for 100 MB transmission at 250 MHz.

D. Complete test and inspection records shall be conducted as described in EIA/TIA 568, 606, 607, and TSB/EIA-40, 67 and 75 telecommunication standards.

END OF SECTION 23 92 10

SECTION 23 92 11
CONDUIT SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Furnish materials, tools, labor, and supervision necessary to fabricate and install complete conduit systems.

B. Conduit systems shall be provided for all wiring, except where the Drawings or other specification sections indicate that wiring is permitted to be installed without conduit.

1.3 STANDARDS AND CODES

A. Methods of fabrication and installation shall comply with the provisions of applicable Section NEC, Article 300.

B. Materials shall be UL and NEC approved for the application intended.

1.4 DESCRIPTION

A. This Section describes the basic materials and methods of installation for circular cross section conduit systems. Other types of conduit or raceways when required shall be as specified in other Sections, or as called for on the Drawings.

1.5 QUALIFICATIONS

A. The materials used in the fabrication of the conduit system shall be products of a manufacturer regularly engaged in the manufacturing of the specified material. Where a manufacturer is named for a particular material, the material of other manufacturers shall be acceptable provided the material meets requirements of the specification.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Coated Rigid Conduit: Full weight, threaded, rigid steel, 40 mil PVC coated on outside, 2 mil urethane coated on inside conduit. Approved sources for this raceway are Robroy "Plastibond-Red" (Westwood Electrical Sales, 440-835-9960), Ocal, Inc "Ocal-Blue" (Greisser Sales, 216-771-6120), or Calpipe Industries “Calbond” (Fields Electrical Sales, 513-228-1010). All associated raceway fittings, sweeps, etc., shall be coated. Field cut raceways shall be touched up with matching finish. Use for all conduit, regardless of size, where installed in earth fill, or where specifically required by the drawings.

B. Rigid Conduit - Aluminum: Full weight, threaded, rigid aluminum conduit may be used for all conduit, regardless of size, where installed exposed outdoors on roofs or in damp/wet locations or where specifically required by the drawings. Expansion fittings and supports shall be utilized to absorb and prevent deflections due to thermal expansion.

C. PVC Conduit: Schedule 40 heavy wall rigid, rated for 90°C cable, composed of polyvinyl chloride and shall conform to NEMA Standards. Conduit, fittings, and pipe-joining materials shall be produced by the same manufacturer. At Contractor's option and where permitted by NEC and local jurisdiction, PVC conduit may be used where buried outside building, or encased in concrete, or in/below floor slabs. Electrical Contractor shall be responsible for upsizing raceway if necessary as required by NEC.

2.2 CONDUIT FITTINGS

A. Rigid Conduit Fittings: Threaded, galvanized malleable iron or heavy steel, water and concrete tight.

B. Metallic Tubing Fittings: Set screw type galvanized steel, concrete tight. Die cast type indentor type fittings will not be allowed.

C. Flexible Metal Conduit Fittings: Squeeze or screw type galvanized malleable iron or steel with nylon insulated throats, or steel with set screws.

D. Liquid-tight Flexible Metal Conduit: Galvanized malleable iron or steel, with watertight gaskets, "O" ring and retainer, and nylon insulated throats.

E. Condulet Fittings: Exposed conduit fittings shall be condulet type for sharp turns, tees, etc. Condulet covers shall be gasketed where exposed to moisture.

F. Threaded conduit terminations for weatherproof applications shall be made by use of Myers Hubs.

2.3 OUTLET BOXES

A. Material, size and installation for outlet boxes shall comply with NEC Article 314.

B. Boxes shall be Raco, Steel City, Appleton or equivalent, catalog numbers listed below are based on Raco, unless otherwise indicated. In general the type of boxes shall be as follows:

1. In stud walls: For single outlet use 4" square by 2-1/8" deep box No. 232 or 233. For ganged outlets use 4-1/2" high by 1-13/16" deep multiple gang boxes No. 951 through No. 958. Boxes to be provided with raised adapters of depth as required for thickness of wall materials.

2. In masonry and poured concrete walls: For single outlets requiring two conduit connections in top and/or bottom of box use 4" square by 2-1/8" deep box No. 232 or 233 with raised square cut adapter. For ganged outlets use 3-3/4" high by 2-1/2" deep multiple gang masonry boxes No. 691 through No. 694 and No. 960 through No. 964.

3. Surface mounted wall outlets: For single outlet use 2-1/8" deep handy box No. 674, for two outlets use 4" square by 2-1/8" deep box No. 232 or 233. For more than two ganged outlets use 3-3/4" by 2-1/2" deep multiple gang masonry boxes No. 692 through No. 694 and No. 960 through No. 964. Boxes to be provided with 1/2" raised cover as required for device.

4. In suspended ceilings: Use 3-1/2" deep octagon box No. 280 or No. 281 with fixture studs and steel mounting bars.

5. In poured concrete ceiling slabs: Use octagon concrete rings with back plates.

6. Where outlet boxes are free standing on conduit stubs in kitchens, laundries, shops and other areas indicated, use Crouse-Hinds Type FS or FD malleable iron cadmium finish boxes with appropriate gasketed cover plate to suit device.

7. Outlets installed outdoors or in wet locations: Use Crouse-Hinds Type FS or FD box with NEMA 3R coverplates listed for "raintight while in use" for receptacles. Covers for switches shall be Crouse Hinds No. DS185. Diecast "bell" type boxes are not acceptable.

8. Floor outlets in above grade concrete slabs: Use concrete tight stamped steel galvanized box with fully adjustable top, Hubbell No. B-2527 for greater than 3" fill, No. B-2529 for 2" to 3" fill. Floor outlets in concrete slabs on grade: Use watertight cast iron box with fully adjustable top, Hubbell No. B-2536 for greater than 3" fill, No. B-2537 for 2" to 3" fill. Furnish for each outlet a No. S-2525 cover. Service fittings shall be as described on the Drawings. Furnish for each outlet in carpeted floor a No. S-3082 carpet flange.

2.4 PULL AND JUNCTION BOXES

A. Construction, size and installation of pull and junction boxes shall comply with NEC, Article 314.

B. Pull and junction boxes shall be fabricated of heavy gauge galvanized steel with screw covers, brass screws and hardware with enamel finish.

C. Pull and junction boxes for installation in poured concrete floors shall be flush type, cast iron, with watertight gasketed covers. Boxes for installation in floors with tile or carpet floor covering shall have recessed covers to accommodate the floor covering.

D. Pull and junction boxes for above grade outdoor installations shall be rain-tight.

E. Grade level junction boxes shall be manufactured by Synertech or CDR Systems Corporation with open flared bottom and cover. Logo on cover to read "ELECTRIC", etc. Enclosures and covers shall be concrete gray color and rated for no less than 5,000 pounds over a 10" x 10" area and be designed and tested to temperatures of -50 degrees F. Material compressive strength should be no less than 11,000 psi. Covers shall be secured with two pentahead stainless steel bolts. Bolts shall be retained in lid when unscrewed. Bolts shall be secured to replaceable threaded inserts with openings at base to allow debris to fall through and thereby avoiding clogged threaded inserts.

2.5 AUXILIARY GUTTERS

A. Construction, sizes and installation of auxiliary gutters shall comply with NEC, Article 366.

2.6 HANGERS AND SUPPORTS

A. Provide conduit hanger and support devices of approved type for required methods of support to include: structural steel members, suspension rods, conduit clamps, concrete inserts, expansion shields, beam clamps and welding pins. All devices shall have galvanized finish or other approved corrosion resistive finish. In general, hangers and supports shall be as follows:

1. Where a multiple run of conduit is routed on surface of structure, use conduit clamps mounted on Unistrut or equal channel so as to maintain clearance between conduit and structure.

2. Where single run of conduit is suspended from overhead; use split ring conduit clamp suspended by steel drop rod.

3. Where multiple parallel runs of conduit are suspended from overhead; use split ring conduit clamps uniformly spaced and supported on trapeze hangers fabricated of Unistrut Channels, suspended by not less than 1/2" continuously threaded steel drop rods.

4. Where conduit is buried in concrete floor slabs; anchor conduit to structural floor with conduit clamps, at 10'-0" (maximum) intervals.

5. Any form of strap iron or wire hangers will not be accepted.

6. Maximum hanger and support spacing shall be in accordance with NEC Sections 342.30 (IMC), 344.30 (GRC), and 358.30 (EMT). Regardless of listed spacing provide additional hangers or supports at not more than 2'-0" from each change of direction and at each side of any box or fitting.

B. Hangers and supports shall be anchored to structure as follows:

1. Hangers and supports anchored to poured concrete: Use malleable iron or steel concrete inserts attached to concrete forms.

2. Hangers or supports anchored to precast concrete: Use self-drilling expansion shields. Expansion shields may also be used where concrete inserts have been missed or additional support is required in poured concrete.

3. Hangers or supports anchored to structural steel: Use beam clamps and/or steel channels as required by structural system.

4. Hangers or supports anchored to metal deck: Use spring clips or approved welding pins. Maximum permissible load on each hanger shall not exceed 50 pounds.

5. The use of explosive force hammer actuated, booster assist or similar anchoring device will not be permitted without prior approval of the Architect.

PART 3 - EXECUTION

3.1 CONDUIT INSTALLATION

A. In general, horizontal runs of conduit shall be installed in ceiling plenum. Conduit for convenience outlets, wall mounted fixtures and other wall outlets shall be routed overhead and concealed in wall to the outlet. Conduit shall not be installed in concrete floor slabs except where conditions will not permit the conduit to be routed overhead.

B. Generally, conduit shall be concealed, except in crawl spaces, tunnels, shafts, mechanical equipment rooms, and at connections to surface panels and free-standing equipment, and as otherwise noted on Drawings. No surface raceways shall be used on the floor.

C. Exposed conduit shall be routed in lines parallel to building construction lines. Exposed conduit locations shall be approved by the Architect prior to installation.

D. No conduit shall be installed less than 6" from piping installed by other trades. Conduits shall be located to avoid ductwork, piping and other obstructions.

E. Certain conduits are permitted to be embedded in structural concrete work. Contractor shall cooperate with other Contractors of their respective trades to effect the following:

1. Reinforcing steel shall be securely anchored in place before installing conduit.

2. No steel reinforcing shall be displaced from plan dimensions without approval of Architect.

3. Conduit shall not be placed over top of reinforcing or under bottom of reinforcing, where crossing beams.

4. Conduit and fittings shall not displace concrete in columns in excess of 4% of total cross-section area of column without approval of Architect.

5. Conduit shall not be placed closer than 3 diameters on center.

6. Maximum size of embedded conduit or pipe shall not exceed 1/3 thickness of structural slab; 2/3 thickness of topping slab.

F. Minimum size conduit shall be 1/2" trade size. Where specific size is not called for on Drawings or in the specification, Contractor shall select size required from Chapter 9 of NEC. Where specific sizes required by Drawings or Specifications are larger than Code requires, the larger size shall be installed.

G. Install the conduit system mechanically and electrically continuous from outlet to outlet and to cabinets, junction or pull boxes. Conduit shall enter and be secured to cabinets and boxes in such a manner that all parts of the system will have electrical continuity. Feeder raceways shall terminate in cabinets and pull boxes with double locknuts and insulating bushings.

H. Metal conduit buried in earth fill shall be protected with an approved corrosion resistant material.

I. Conduits shall be capped during construction to prevent the entrance of foreign materials and moisture.

J. Where conduits cross building expansion joints, O-Z Gedney Company type "DX" conduit expansion fittings complete with bonding jumpers shall be used.

K. Contractor shall cut and patch existing construction for conduit installation as required.

3.2 OUTLET BOX INSTALLATION

A. Outlet boxes shall be installed for fixtures, switches, receptacles and other devices.

B. Approximate location of outlets are shown on the plans, but each outlet location shall be verified by the Contractor before installing the outlet box.

C. Openings for electrical boxes in fire-rated walls that do not exceed 16 square inches in area are permitted in fire-rated construction provided that the aggregate area of such openings does not exceed 100 square inches for any 100 square feet of wall area.

D. Where service utility boxes greater than 16 square inches exist in fire-rated wall construction, if the opening is not otherwise detailed to maintain the fire-rated integrity of the wall, provide firestopping wrap to the back side of each utility box.

E. Outlet boxes on opposite sides of fire-rated walls shall be separated by a horizontal distance of not less than 24 inches.

F. Outlet boxes installed flush in a common wall shall not be back-to-back or through-wall type, unless construction requires same. Where it is necessary to install boxes back-to-back, install sound absorption material between boxes and seal the conduit nipple between boxes with duct seal.

G. Boxes located on opposite sides of a common wall that are connected by 12" conduit length or less, shall have the conduit openings plugged with duct seal at both ends.

H. Outlet boxes shall be installed plumb and square with wall face and with front of box or cover located within 1/8" of face of finish wall. Boxes in masonry shall be set with bottom of the box tight to the masonry unit.

3.3 PULL AND JUNCTION BOX AND GUTTER INSTALLATION

A. Install pull boxes, junction boxes and auxiliary wiring gutters where indicated on Drawings and where required to facilitate installation of the wiring.

B. For concealed conduit, install boxes flush with ceiling or wall, with covers accessible and easily removable. Where flush boxes are installed in finished ceilings or walls, provide cover which shall exceed the box face dimensions by a sufficient amount to allow no gap between box and finished material.

C. Boxes shall not be exposed in finished, occupied rooms, without prior approval of Architect.

3.4 HANGER AND SUPPORT INSTALLATION

A. Hangers and supports shall be installed for all conduit and boxes.

B. Conduit and boxes shall not be attached to or supported from mechanical pipes, plumbing pipes or sheet metal ducts.

C. Conduits routed in lay-in grid ceiling plenum shall not be supported from the ceiling hanger iron or ceiling tees.

END OF SECTION 23 92 11

SECTION 23 92 12
PULLING CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Provide material, equipment, labor, and supervision as required for the complete installation of wire and cable in raceways.

1.3 CODES AND STANDARDS

A. Methods of installation shall comply with the provisions of applicable sections of NEC Article 300.

PART 2 - PRODUCTS

2.1 Products shall be used as described under Part 3.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Suitable installation equipment shall be provided to prevent conductor and raceway damage during the installation of feeders. Ropes used for pulling of feeders in metallic raceways shall be made of polyethylene or other suitable non-metallic material. Metallic ropes shall not be used.

B. Cable installation in PVC or similar non-metallic raceways or innerducts require the use of woven pull tapes. Tapes shall be Fibertek or equal.

C. A #14 galvanized steel fish wire or a plastic line having a tensile strength of not less than 200 pounds shall be installed in each conduit, except underground conduits, in which installation of conductors is not included in this section of the Specification. A #10 AWG bare, hard drawn copper shall be installed in each underground conduit or duct, in which installation of conductors is not included in this section of the Specification. Woven tape with embedded copper conductor may be used in lieu of #10 bare. Fibertek "Tracertape" or approved equal.

D. Fish wires and lines shall be free from splices and shall have ample exposed length at each end.

E. Wire pulling lubricants, if used, shall conform to UL requirements applicable to the several insulation and raceway materials.

F. Cables shall not be bent, either permanently or temporarily during installation, to radii less than 10 times the outer diameters, except where shorter radii are approved for conditions making the specified radius impractical.

G. Pulling lines shall be attached to conductor cables by means of either woven basket grips or pulling eyes attached directly to the conductors. Rope hitches shall not be used. All cables to be installed in a single conduit shall be pulled in together. Where polyethylene insulation is used and a pulling lubricant is required, the lubricant shall be certified by the manufacturer to be non-injurious to polyethylene insulation.

H. Refer to Section 260120 for cable supports and boxes required for installation of all vertical feeders.

END OF SECTION 23 92 12

SECTION 23 93 10
CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies mechanical system equipment and piping identification and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

PART 2 - PRODUCTS

2.1 TEMPERATURE SENSORS

A. General

1. Each temperature sensor shall match the requirements of the associated temperature controller and shall be based upon 10-K thermistors.
2. Each sensor shall be designed for the appropriate application (i.e., duct, immersion, etc.) and be provided with all necessary installation accessories.
3. Ranges shall be selected to the middle of the control range.
4. Space sensors in office spaces shall have LCD display, set point adjustment, and service port.
5. Install thermostats and sensors at 4’-6" AFF to bottom unless otherwise noted on Architectural Drawings. Coordinate installation with the work of other trades before any rough-ins are made. Thermostats may be installed up to 500 feet from controller.
6. Provide temperature sensors as required to meet the sequence of operation.

B. Wall Mounted

1. Accuracy: +/- 0.5°F at calibration point.
2. Provide with the following options when specified:
    a. Setpoint warmer/cooler
    b. Individual heating/cooling setpoint
    c. Momentary override request for activation of after-hours operation
    d. Analog thermometer
    e. Integral LCD display with the following capabilities when specified:
        1). Display room air temperature
        2). Display and adjust room comfort setpoint
        3). Display and adjust fan operation status
        4). Setpoint override request via setpoint adjust dial or buttons

5). Timed override request via occupancy override with status indication for activation of after-hours setpoint operation

6). Occupancy sensor status

7). Toggle between °F and °C.

8). Toggle between temperature and humidity

f. Security Sensor: stainless steel cover plate with insulated back and security screws

C. Duct Mounted - Averaging

1. Accuracy: +/- 0.5°F at calibration point.
2. Use where ducts are larger than 10 ft2 or are subject to temperature stratification.
3. Provide with all required mounting hardware.

D. Duct Mounted – Point

1. Accuracy: +/- 0.5°F at calibration point.
2. Use where ducts are smaller than 9 ft2 or are not subject to temperature stratification.
3. Provide with mounting plate.

E. Well Mounted

1. Accuracy: +/- 0.5°F at calibration point.
2. Brass or stainless-steel socket with minimum insertion length of 2.5 inches for pipes up to 4" diameter and 6 inches for pipes up to 10" diameter.

F. Exterior

1. Accuracy: +/- 0.5°F at calibration point.
2. Weather resistant.
3. Wind and sun shield.
4. Enclosure suitable for outdoor temperatures of -20 to 110°F.

G. High Limit Thermostat

1. Averaging type, with adjustable high limit.
2. Manual reset type.
3. Form C contacts.
4. Sensing element of 20 ft minimum length.
5. One sensor to cover 24 sq. ft. of protected area.

H. Low Limit Thermostat

1. Averaging type, with adjustable low limit.
2. Manual reset type.
3. Form C contacts.
4. Sensing element of 20 ft minimum length.
5. One sensor to cover 24 sq. ft. of protected area.

I. Thermowell

1. When thermowells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and sensor.

2. Thermowells shall be pressure rated and constructed in accordance with the system working pressure.

3. Thermowells and sensors shall be mounted in a direct mount (no adapter) offering faster installation or 1/2" NFT saddle and allow easy access to the sensor for repair or replacement.

4. Provide brass thermowells for copper piping applications and stainless steel thermowells for steel piping applications.

2.2 PRESSURE SENSORS

A. Duct Mounted Airflow Proving Switch

1. Size to be determined by Contractor to accommodate requirements of application

B. Duct Mounted High Static Safety Switch

1. Size to be determined by Contractor to accommodate requirements of application.

2. Manual reset type with SPDT contacts rated for 2 amps at 120VAC.

3. Adjustable setpoint suitable for application.

C. Duct Mounted Low Static Safety Switch

1. Size to be determined by Contractor to accommodate requirements of application.

2. Manual reset type with SPDT contacts rated for 2 amps at 120VAC.

3. Adjustable setpoint suitable for application.

D. Air Filter Status Switch

1. Automatic reset type with SPDT contacts rated for 2 amps at 120VAC.

2. Suitable range and differential adjustment for intended service.

E. Differential Pressure Transmitter

1. General

a. Constructed to withstand 100% pressure over-range without damage and to hold calibration accuracy when subject to momentary 40% over-range input.

b. Transmit 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal

c. Sensors used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow permanent, easy-to-use connection.

2. Low Differential Water pressure Applications (0 to 20 in. w.g.)

a. 4 to 20 mA linear output

b. 0.01 to 20 in. w.g. input differential pressure range

c. Maintain accuracy up to 20 to 1 ratio turndown

d. Accuracy: 0.2% of full span

3. Medium to High Differential Water Pressure Applications (Over 21 in. w.g.)

a. Differential pressure range 10 in. w.g. to 300 PSI

b. Accuracy: +1% of full span (includes non-linearity, hysteresis, and repeatability)

4. Building Differential Air Pressure Applications (-1 to +1 in. w.g.)

a. 4 to 20 mA linear output

b. -1.00 to +1.00 in. w.g. input differential pressure ranges. (Select range appropriate for system application)

c. Maintain accuracy up to 20 to 1 ratio turndown

d. Accuracy: +0.2% of full span

5. Low Differential Air Pressure Applications (0 to 2.5 in. w.g.)

a. 4 to 20 mA linear output

b. 0.00 to 5.00 in. w.g. input differential pressure ranges. (Select range appropriate for system application)

c. Maintain accuracy up to 20 to 1 ratio turndown

d. Accuracy: +0.25%, or 0.5% of full span

6. Medium Differential Air Pressure Applications (5 to 21 in. w.g.)

a. 4 to 20 mA linear output

b. 5.00 to 21.00 in. w.g. input differential pressure ranges. (Select range appropriate for system application)

c. Maintain accuracy up to 20 to 1 ratio turndown

d. Accuracy: 1% F.S. (best straight line) Static Pressure Effect: 0.5% F.S. (to 100 psig)

e. Thermal Effects: <+.033 F.S./°F. over 40°F to 100°F (calibrated at 70°F)

2.3 HUMIDITY SENSORS

A. General

1. The sensor shall be a solid-state type, relative humidity sensor of the Thin Film Capacitance or Bulk Polymer Design. The sensor element shall resist service contamination.

2. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.

B. Wall Mounted Sensor

1. Accuracy: 2% full range with linear output.

2. Operating range: 0 to 99% RH.

C. Wall Mounted Humidistat

1. Accuracy: 2% full range with linear output.

2. Operating range: 0 to 99% RH.

3. Provide with the following options when specified:

a. Humidity setpoint adjustment

b. Analog sensor

c. Integral LCD display with the following capabilities when specified:

1). Display room humidity

2). Display and adjust room comfort setpoint

3). Setpoint override request via setpoint adjust dial or buttons

4). Timed override request via occupancy override with status indication for activation of after-hours setpoint operation

5). Occupancy sensor status

6). Toggle between temperature and humidity

d. Security Sensor: stainless steel cover plate with insulated back and security screws

D. Duct Mounted Humidity Sensor

1. Accuracy: 2% full range with linear output.
2. Operating range: 0 to 99% RH.
3. Constructed of 304 stainless steel with neoprene grommet, bushings, and mounting bracket

E. Duct Mounted Humidity Switch

1. Accuracy: 3% at 40% RH and 73°F.
2. Setpoint Range: 20 to 90% RH.
3. Constructed of 304 stainless steel with neoprene grommet, bushings, and mounting bracket

F. Exterior

1. Accuracy: 2% full range with linear output.
2. Operating range: 0 to 99% RH.
3. Weather resistant.
4. Wind and sun shield.
5. Enclosure suitable for outdoor temperatures of -20 to 110°F.

2.4 FLOW SENSORS

A. Airflow Measuring Station – Duct Mounted

1. General

a. Specification and design are based on thermal dispersion technology. Other technologies may be acceptable if comparable performance is demonstrated to the Engineer's satisfaction.

2. Installed Accuracy

a. Airflow shall be +/- 3% of reading.

b. Temperature shall be +/- 0.15 °F.

3. Calibrated Range

a. Sensor shall be calibrated for airstream velocities from 50 to 5,000 fpm.

4. Operating Temperature

a. Probe shall be operable in airstream temperatures from -20 to 160 °F.

5. Construction

a. Provided with air straightener for sizes over 17 square feet (1.6 sq. meters).

b. Fabricated of galvanized steel or aluminum casing of appropriate thickness for slip fits or with 90° connecting flanges in configuration and size equal to that of the duct into which it is mounted.

c. Provide with an air directionalizer and parallel cell profile suppressor (3/4" maximum cell) across the entering air stream and mechanically fastened to the casing in such a way to withstand velocities up to 5000 feet per minute.

d. Probe(s) shall be constructed of an airfoil shaped aluminum extrusion containing the sensor circuit(s).

6. Acceptable Manufacturers: Subject to compliance with requirements, provide Airflow measuring stations as manufactured by one of the following: Air Monitor Corporation, Ebtron, NJK Precision, or Paragon Controls Inc.

B. Airflow Measuring Station – Fan Inlet

1. General:

a. Provide differential pressure transducers of range appropriate for application.

b. Calibration of differential pressure reading and conversion to airflow value shall be the responsibility of the controls contractor.

c. Differential pressure transducer output shall be 4-20 mA

d. Differential pressure transducer shall include integral LCD display

e. Coordinate pressure fitting requirements with fan manufacturer's pressure sensing ports and tubing.

2. Installed Accuracy

a. Differential pressure accuracy shall be +/-1% of full span

3. Acceptable Manufacturers: Subject to compliance with requirements, provide Airflow measuring stations as manufactured by one of the following: Air Monitor Corporation, Paragon Controls Inc., Setra, or Veris.

C. Airflow Measuring Sensor – Single Probe

1. General

a. Adjustable insertion length up to 8".

b. 4 to 20 mA or 0 to 10 VDC linear output signal.

D. Water Flow Switch

1. Stainless steel or bronze paddle.

2. Contractor to select appropriate range and differential adjustment for application.

3. NEMA Type 1 enclosure.

4. Bellows-actuated snap-acting type with pilot-duty rating, stainless steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 4 enclosure.

2.5 LEAK DETECTORS

A. Provide spot leak detectors that can be secured to the floor or secured to a drain pan. The detection shall use a microchip controlled energized probes. The detector shall operate on 24Vor less. Provide a way to adjust the height of the leak probes. The SPDT contacts shall be inside a watertight enclosure.

2.6 CURRENT SENSORS

A. Current Switch

1. Self-powered, with adjustable trip current.

2. Size to be determined by Contractor to accommodate voltage and current requirements of application.

3. Form C contacts

4. Comply with ISA 50.0.01, current-sensing fixed or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

B. Current Transducer

1. A current to voltage or current to mA transducer shall be provided. The current transducer shall include:

a. 6X input over amp rating for AC inrushes of up to 120 amps

b. Manufactured to UL 1244

c. Accuracy: +.5%, Ripple +1%

d. Minimum load resistance 30kOhm

e. Input 0-20 amps

f. Output 4-20 mA

g. Transducer shall be powered by a 24 VDC regulated power supply (24 VDC +5%)

h. Acceptable manufacturers: Setra or approved equal

2.7 VOLTAGE SENSORS

A. Voltage Transmitter (100 to 600 VAC)

1. Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

2.8 OCCUPANCY SENSORS

A. Wall Mounted

1. Single wall switch with integral passive infrared sensor (PIR) technology shall be universal line voltage type with adaptive learning technology and 180 degree coverage.

a. Acceptable Manufacturers: Hubbell #LHIRS1 Series, Leviton #ODS15-ID Series, Philips #LRS2210 Series, Sensor Switch #WSX Series, or Wattstopper #PW-100 Series.

2. Single wall switch with integral passive infrared sensor (PIR) technology and LED nightlight shall be 120 or 277 volt type, as required per Drawings, with 180 degree coverage.

a. Acceptable Manufacturers: Hubbell #LHN-IRS Series, Leviton #OSSNL-ID Series, Philips #LRS2230 Series, Sensor Switch #WSX-NL Series, or Wattstopper #PW-103N Series.

3. Dual wall switch with integral passive infrared sensor (PIR) technology and LED nightlight shall be 120 or 277 volt type, as required per Drawings, with 180 degree coverage.

a. Acceptable Manufacturers: Hubbell (not available), Sensor Switch #WSX-2P-NL Series, or Wattstopper #CS-350-N Series.

4. Single wall switch with integral dual technology sensor (PIR and ultrasonic) shall be universal line voltage type with adaptive learning technology and 180 degree coverage.

a. Acceptable Manufacturers: Hubbell #LHMTS1 Series, Leviton #OSSMT-MD Series, Philips #LRS2220 Series, Sensor Switch #WSX-PDT Series, or Wattstopper #DW-100 Series.

5. Dual wall switch with integral dual technology sensor (PIR and ultrasonic) shall be universal line voltage type with adaptive learning technology and 180 degree coverage.

a. Acceptable Manufacturers: Hubbell #LHMTD2 Series, Leviton #OSSMD-MT Series, Philips #LRS2225 Series, Sensor Switch #WSX-PDT-2P Series, or Wattstopper #DW-200 Series.

6. Single wall switch with integral passive infrared sensor (PIR) technology with 0-10V dimming capabilities shall be universal line voltage type with adaptive learning technology and 180 degree coverage.

a. Acceptable Manufacturers: Hubbell #LHD-IRS Series, Sensor Switch #WSX-D Series, or Wattstopper #PW-311 Series.

7. Single wall switch with integral dual technology sensor (PIR and ultrasonic) with 0-10V dimming capabilities shall be universal line voltage type with adaptive learning technology and 180 degree coverage.

a. Acceptable Manufacturers: Sensor Switch #WSX-PDT-D Series or Wattstopper #DW-311 Series.

B. Ceiling Mounted

1. Ceiling mounted passive infrared sensors (PIR only) technology sensors shall be low voltage type with adaptive learning technology, 360 degree coverage area of 1000 square feet minimum, isolated relay for use by BAS system and integral light level sensor.

a. Acceptable Manufacturers: Hubbell #OMNIIRP Series, Leviton #OSC15-IOW Series, Philips #LRM2250 Series, Sensor Switch #CM-10-R-P Series, or Wattstopper #CI-300 Series.

2. Ceiling mounted dual technology sensors (PIR and ultrasonic) shall be low voltage type with adaptive learning technology, 360 degree coverage area of 1000 square feet minimum, isolated relay for use by BAS system, and integral light level sensor.

a. Acceptable Manufacturers: Hubbell #OMNIDTRP Series, Leviton #OSC10-M, Philips #LRM2255 Series, Sensor Switch #CM-PDT-9-R-P Series, or Wattstopper #DT-300 Series.

2.9 CARBON DIOXIDE SENSORS

A. Wall Mounted

1. Suitable over a temperature range of 20 to 120°F

2. Calibrated for 0 to 2 percent, with continues or averaged reading

3. 4 to 20 mA output

4. Provide with the following options when specified:

a. Security Sensor: stainless steel cover plate with insulated back and security screws

B. Duct Mounted

1. Suitable over a temperature range of 20 to 120°F

2. Calibrated for 0 to 2 percent, with continues or averaged reading

3. 4 to 20 mA output

2.10 RELAYS

A. Size to be determined by Contractor to accommodate voltage and current requirement of application.

B. Control Pilot Relays

1. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
2. Mounting Bases shall be snap-mount.
3. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
4. Contacts shall be rated for 10 amps at 120VAC.
5. Relays shall have an integral indicator light and check button.

C. Lighting Control Relays

1. Lighting control relays shall be latching with integral status contacts.
2. Contacts shall be rated for 20 amps at 277 VAC.
3. The coil shall be a split low-voltage coil that moves the line voltage contact armature to the On or Off latched position.
4. Lighting control relays shall be controlled by:
   a. Pulsed Tristate Output – Preferred method.
   b. Pulsed Paired Binary Outputs.
   c. A Binary Input to the Facility Management System shall monitor integral status contacts on the lighting control relay. Relay status contacts shall be of the "dry-contact" type.
5. The relay shall be designed so that power outages do not result in a change-of-state, and so that multiple same state commands will simply maintain the commanded state. Example: Multiple Off command pulses shall simply keep the contacts in the Off position.

2.11 TRANSFORMERS AND POWER SUPPLIES

1. Size to be determined by Contractor.
2. Coordinate electrical connections with Electrical Contractor.
3. Power supplies for controllers shall be a transformer with a fuse or circuit breaker. Power supplies for other devices can be plain transformers.

PART 3 - EXECUTION

3.1 CONTROL DEVICE

A. For each control device (i.e. sensor, switch, actuator, terminal strip, relay, etc.) provide and install an adhesive laminated label which clearly and uniquely identifies device.

B. Control device labeling shall be coordinated with as-built wiring diagrams, such that any device can be referenced to the wiring diagrams.

C. Include the following (as a minimum)

1. Device Identifier
2. Controlling/monitoring controller
3. Power source

3.2 WIRING IDENTIFICATION

A. Label all Controller I/O wiring at each end (controller and device) with an identifier which clearly indicates controller and terminating point number.

3.3 PANEL NAMEPLATES

A. Permanently adhere nameplates on all control system cabinets.

3.4 TRANSFORMERS

A. For each control transformer, clearly note the following

1. Power Source (including panel name, location, and circuit number)
2. Device(s) served.

END OF SECTION 23 93 10

SECTION 23 93 20
ELECTRONIC CONTROL VALVES AND ACTUATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE

A. This Section specifies electric control valves and valve actuators, and includes general descriptions and installation methods.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all work described in this Section.

1.3 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 GENERAL

A. All control valves shall be factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of the piping system, unless indicated otherwise.

B. Valves for two-position isolation applications shall be either standard ball valves or butterfly valves. Two-position isolation valves shall be full port line size.

C. Valves for modulating applications shall be either characterized ball valves or globe valves.

D. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional (except as noted).

E. Subject to project requirements, provide actuators as manufactured by one of the following: Belimo Aircontrols, Inc. or Siemens.

F. All actuators shall be by a single manufacturer unless approved otherwise by Engineer.

2.2 STANDARD BALL VALVE

A. Valve Body:

1. NPS 2” and Smaller:

a. Nickel-plated forged brass body rated at no less than 400 psi, stainless steel ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-ring packing design, and fiberglass reinforced Teflon seats.

b. NPS ¾” and Smaller for Terminal Units: Nickel plated forged brass body rated at no less than 600 psi, chrome plated brass ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-Ring packing design, and graphite reinforced PTFE seats.

2. NPS 2-1/2" to 4"

a. Forged brass body with ASME 150 ductile iron flanges with stainless steel ball and blowout proof stem, rotating flanges, with a dual EPDM O-ring packing design, and fiberglass reinforced Teflon seats.

B. Sizing:

1. Two-Position: Line size or size using a pressure differential of 1 psi.

C. Close-Off Pressure Rating:

1. NPS 1" and larger: 100 PSI

2. NPS ¾" and Smaller for Terminal Units: 200 PSI.

D. The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory with a single screw on a four-way DIN mounting-base.

2.3 CHARACTERIZED BALL VALVE

A. Valve Body:

1. NPS 2" and Smaller:

a. Nickel-plated forged brass body rated at no less than 400 psi, stainless steel ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.

b. NPS ¾" and Smaller for Terminal Units: Nickel plated forged brass body rated at no less than 600 psi, chrome plated brass ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-Ring packing design, graphite reinforced PTFE seats, and a TEFZEL flow characterizing disc.

2. NPS 2-1/2" to 4"

a. Forged brass body with ASME 150 ductile iron flanges with stainless steel ball and blowout proof stem, rotating flanges, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.

B. Sizing:

1. Two-Way Modulating: 5 psig or twice the load pressure drop, whichever is more. Size valve for 50% valve authority

2. Three-Way Modulating: Twice the load pressure drop, but not more than 5 psig.

C. Close-Off Pressure Rating:

1. NPS 1" and larger: 100 PSI

2. NPS ¾" and Smaller for Terminal Units: 200 PSI.

D. The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory with a single screw on a four-way DIN mounting-base.

2.4 BUTTERFLY VALVES

A. Valve Body (2" to 20" resilient seat ASME Class 125/150 Flanged):

1. Cast iron bodies meeting ASTM A126 Class B requirements, ASME class 125/150 flange requirements, and fully lugged.

2. Valves seats shall be EPDM.

3. Valves disks shall be ductile iron with Nylon 11 coating.

4. Valves stems shall be stainless steel.

B. Flow characteristics shall be of equal percentage up to 70 degrees of disk rotation.

C. Valves shall be maintenance free.

D. Valves shall be provided with a 3 year warranty.

E. Valves shall be UL-recognized and CSA-certified.

F. GLOBE VALVES (1/2" THROUGH 2")

G. Valve Body:

1. Brass body with stainless steel stem.

2. Valves with brass plugs and seats shall have stem seals with self-adjusting Ethylene Propylene Rubber (EPR) Ring Pack U-Cups.

3. Valves with stainless steel plugs and seats shall have valve stem seals with spring loaded PTFE and Elastomer V-Rings.

H. Flow characteristics shall be of equal percentage for two-way valves and linear for three-way valves.

I. Valves shall meet the pressure and temperature requirements of ANSI B16.15, Class 250.

J. Valves with brass trim shall have a maximum leakage specification of 0.01% of maximum flow per ANSI/FCI 70-2, Class 4.

K. Valves with stainless steel trims shall have a maximum leakage of 0.05% of maximum flow.

L. Valves shall be serviceable without being removed from the pipe.

M. Valves shall be provided with a 3 year warranty.

N. Valves electric actuators shall be UL-recognized or CSA-certified.

2.5 GLOBE VALVES (2-1/2" TO 6")

A. Valve Body:

1. Bodies shall be manufactured from cast iron.

2. Valve stems shall be manufactured from 316 series stainless steel.

3. Valves shall have stem seals with Ethylene Propylene Terpolymer (EPT) Ring Pack U-Cups.

B. Flow characteristics shall be equal modified linear.

C. Valves shall meet the pressure and temperature requirements of ANSI B16.15, Class 125.

D. Valves shall have a maximum leakage specification of 0.01% of maximum flow per ANSI/FCI 70-2, Class 3.

E. Valves shall be serviceable without being removed from the pipe.

F. Valves shall be provided with a 3 year warranty.

G. Valve electric actuators shall be UL-recognized or CSA-certified.

2.6 ACTUATORS:

A. Electronic Actuators:

1. Valve Actuator Sizing: Size for torque required for valve close off at 150 percent of total system (head) pressure for two-way valves; and 100 percent of pressure differential across the valve or 100 percent of total system (pump) head differential pressure for three-way valves.

2. Select running and break away torque ratings to allow the actuator to close while the system is operational for all applications.

3. Coupling: Directly couple end mount to stem, shaft, or ISO-style direct-coupled mounting pad.
4. Mounting: Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
5. Overload Protection: Electronic overload or digital rotation-sensing circuitry without the use of end switches to deactivate the actuator at the end of rotation.
6. Fail-Safe Operation: Mechanical, spring-return mechanism.
7. Power Requirements (Two-Position Spring Return): 24 Vac unless noted otherwise
8. Power Requirements (Modulating): 10 VA at 24 VAC or 8 W at 24 VDC.
9. Temperature Rating: -20°F to 120°F
10. Proportional Signal: 2 to 10 VDC or 4 to 20 mA, and 2 to 10 VDC position feedback signal.
11. Run Time: 12 seconds open, 5 seconds closed.
12. Housing: Minimum requirement NEMA type 2 / IP54 mounted in any orientation.
13. Agency Listing: ISO 9001, cULus, and CSA C22.2 No. 24-93.
14. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.
15. Unless approved by the Engineer, all actuators shall be supplied by only one of the following approved manufacturers: Belimo, Siemens, Honeywell, or Johnson Controls.

B. Position Indicators

1. Electric Valve Position Indicator:
   a. Visual scale indicating percent of travel and 2 to 10 VDC feedback signal.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Install valves and actuators in strict accordance with the manufacturer's recommendations.

B. Ensure that adequate clearance is maintained to allow future testing, adjusting, calibration, servicing, and replacement of valve and actuator.

3.2 CONNECTIONS

A. Complete all connections to all control valves and actuators required for a complete and functional system.

3.3 STARTUP, TESTING AND ADJUSTING

A. Test and adjust valve in strict accordance with the manufacturer's recommendations.

END OF SECTION 23 93 20

SECTION 23 93 30
ELECTRONIC CONTROL DAMPERS AND ACTUATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. The other Specifications of this Division complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies requirements for the purchase and installation of Control Dampers. This section does not apply to Smoke Dampers or Combination Fire/Smoke Dampers, which are specified separately.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all Control work described in this Section.

1.3 CODES AND STANDARDS

A. Dampers shall be rated in accordance with:

1. AMCA 500 - Test Methods for Louvers, Dampers and Shutters

2. AMCA 511 - Certified Ratings Program for Air Control Devices

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide dampers as manufactured by one of the following: American Warming and Ventilating, Arrow United, Greenheck, Ruskin, or Tamco.

2.2 GENERAL

A. Automatic dampers shall be single blade or multiple blades as applicable.

B. All dampers are sized on the drawings.

C. All dampers furnished integral with equipment by equipment manufacturers must meet the requirements listed in this section.

D. Provide Parallel or Opposed blades as indicated on drawings, with a maximum blade width of 6 inches.

E. Provide dampers which meet or exceed the pressure classification of the system in which they are installed.

F. Provide with the following seal options when specified:

1. Blade: Seals shall be rated for operation between -70 and 275°F, and shall be mechanically attached to the blade.

2. Jamb: Flexible metal compression type.

G. Unless noted otherwise, damper frame shall be 16 ga. galvanized steel (standard applications) or 316 stainless steel (applications where damper is exposed to moisture or other environmental conditions requiring stainless steel construction) formed into a 5 in. x 1 in. structural hat channel. Top and bottom frame members on dampers less than 17 in. high shall be low profile design to maximize the free area of these smaller dampers. Frame shall be 4-piece construction with 1 ½ in. (minimum) integral overlapping gusset reinforcements in each corner to assure square corners and provide maximum resistance to racking. Stainless steel frame is optional.

2.3 STANDARD STAMPED METAL "3V" BLADE DAMPERS

A. Damper blades shall be 16 ga. galvanized steel (standard applications) or 316 stainless steel (applications where damper is exposed to moisture or other environmental conditions requiring stainless steel construction) strengthened by three longitudinal 1 in. deep V-grooves running the entire length of each blade. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper. Provide symmetrical blades of varying size as required to completely fill the damper opening. Blade orientation is horizontal. 304 stainless steel blade is optional.

2.4 AIRFOIL BLADE DAMPERS

A. Damper blades shall be airfoil shape galvanized steel double skin construction with 2 skins of 20 ga. (standard applications) or 316 stainless steel double skin construction with 14 ga. equivalence (applications where damper is exposed to moisture or other environmental conditions requiring stainless steel construction). Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper. Provide symmetrical blades of varying size as required to completely fill the damper opening. Blade orientation is horizontal. Stainless steel blade is optional.

2.5 AIRFOIL BLADE DAMPERS, ALUMINUM CONSTRUCTION

A. Damper blades shall be heavy gauge extruded aluminum airfoil shape with metal blade to blade overlap. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper. Provide symmetrical blades of varying size as required to completely fill the damper opening. Blade orientation is horizontal.

2.6 INSULATED AIRFOIL BLADE DAMPERS

A. Damper blades shall be airfoil shape heavy gauge extruded aluminum double skin construction (14 ga. equivalence) filled with ½ in. polystyrene on each blade. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper. Provide symmetrical blades of varying size as required to completely fill the damper opening. Blade orientation is horizontal. Stainless steel blade is optional.

2.7 THERMALLY BROKEN BLADE DAMPERS

A. Damper blades shall be heavy gauge extruded aluminum airfoil shape with metal blade to blade overlap. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper. Blade orientation is horizontal, and operation is parallel or opposed. Polyurethane foam fills the airfoil blade cavity giving the blade its thermal transfer properties. Ends of blade have a thermal break to isolate the transfer of heat/cold through the aluminum material from one side of the blade to the other.

2.8 THERMALLY BROKEN BLADE AND FRAME DAMPERS

A. Damper blades shall be heavy gauge extruded aluminum airfoil shape with metal blade to blade overlap. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper. Blade orientation is horizontal, and operation is parallel or opposed. Polyurethane foam fills the airfoil blade cavity giving the blade its thermal transfer properties. Ends of blade have a thermal break to isolate the transfer of heat/cold through the aluminum material from one side of the blade to the other.

B. Damper frame shall be aluminum formed into a 5 in. x 1 in. structural hat channel. Top and bottom frame members on dampers less than 17 in. high shall be low profile design to maximize the free area of these smaller dampers. Frame shall be 4-piece construction with 1½ in. (minimum) integral overlapping gusset reinforcements in each corner to assure square corners and provide maximum resistance to racking.

C. Quick connect damper frame shall be aluminum formed into a 4 in. x 1 in. structural hat channel with a 0.125 in. minimum wall thickness.

1. Thermally broken with dual polyurethane resin gaps.

2. Quick connect mounting is a flangeless frame ordered oversized to mate with a connecting duct.

2.9 ACTUATORS

A. Electronic Actuators:

1. Damper Actuator Sizing: Size for torque as outlined below:

a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.

b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.

c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.

d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.

e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.

f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

2. Select running and break away torque ratings to allow the actuator to close while the system is operational for all applications.

3. Coupling: Directly couple end mount to stem, shaft, or ISO-style direct-coupled mounting pad.

4. Mounting: Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.

5. Overload Protection: Electronic overload or digital rotation-sensing circuitry without the use of end switches to deactivate the actuator at the end of rotation.

6. Fail-Safe Operation: Mechanical, spring-return mechanism.

7. Power Requirements (Two-Position Spring Return): 24 Vac unless noted otherwise

8. Power Requirements (Modulating): 10 VA at 24 VAC or 8 W at 24 VDC.

9. Temperature Rating: -20°F to 120°F

10. Proportional Signal: 2 to 10 VDC or 4 to 20 mA, and 2 to 10 VDC position feedback signal.

11. Run Time: 12 seconds open, 5 seconds closed.
12. Housing: Minimum requirement NEMA type 2 / IP54 mounted in any orientation.
13. Agency Listing: ISO 9001, cULus, and CSA C22.2 No. 24-93.
14. Where required to successfully implement the Sequence of Operations, furnish dampers with integral end switches and/or analog feedback as indicated.
15. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.
16. Unless approved by the Engineer, all actuators shall be supplied by only one of the following approved manufacturers: Belimo, Siemens, Honeywell, or Johnson Controls.

B. Position Indicators

1. Electric Damper Position Indicator:

a. Visual scale indicating percent of travel and 2 to 10 VDC feedback signal.

PART 3 - EXECUTION

3.1 GENERAL

A. Install Control Dampers as indicated on plans, and as required to successfully implement Sequence of Operations.

3.2 COORDINATION

A. Coordinate damper locations with ductwork, and ensure that proper service access is maintained.

3.3 INSTALLATION

A. Install dampers in accordance with manufacturer's installation instructions.

B. Install dampers square and free from racking.

C. Do not compress or stretch damper frame into duct or opening.

D. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

3.4 ADJUSTING, CLEANING AND PROTECTION

A. Adjust damper so it can be cycled through entire range of operation with no binding or sticking.

END OF SECTION 23 93 30

SECTION 23 93 50
HYDRONIC ENERGY MEASUREMENT SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 25 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section specifies basic requirements for walls, roof and floor penetrations.

B. Furnish all equipment, materials, labor, and supervision necessary to make all required mechanical penetrations as described herein.

1.3 CODES AND STANDARDS

A. Ohio Building Code (OBC)

B. National Electric Code (NEC)

C. Underwriters' Laboratory (UL)

D. National Institute of Standards and Technology (NIST)

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

1.5 WARRANTY

A. All equipment shall be covered by the manufacturer's two year warranty.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Onicon

B. Hoffer Flow Controls

C. Flow Technology

2.2 GENERAL

A. The entire energy measurement system shall be built and calibrated by a single manufacturer.

B. The system shall consist of a flow meter, two temperature sensors, a Btu meter, temperature sensor thermowells, and all required mechanical installation hardware.

C. A certificate of NIST traceable calibration shall be provided with each system.

2.3 FLOW METER

A. Insertion type flow meters shall be provided with all installation hardware necessary to enable insertion and removal of the meter without system shutdown

B. Flow meters shall be hand insertable up to 400 psi.

C. Flow meter shall be a dual turbine design, with two contra-rotating axial turbines.

D. Turbine revolutions shall be sensed via an electronic, impedance-based sensing and an averaging circuit to reduce measurement errors due to swirl and flow profile distortion.

E. Each flow meter shall be individually wet-calibrated against a primary volumetric standard that is accurate to within 0.1% and traceable to NIST*.

F. A certificate of calibration shall be provided with each flow meter.

G. Accuracy:

1. Within ± 0.5% of rate at the calibrated velocity
2. Within ± 1% of rate over a 10:1 turndown (3.0 to 30 ft/s)
3. Within ± 2% of rate over a 50:1 turndown (from 0.4 to 20 ft/s).

H. Output signal shall be a 0-15 V square wave pulse.

2.4 TEMPERATURE SENSORS

A. Temperature sensors shall be loop-powered current based (mA) sensors and shall be bath-calibrated and matched (NIST* traceable) for the specific temperature range for each application.

B. The calculated differential temperature used in the energy calculation shall be accurate to within $\pm 0.15^{\circ}$F (including the error from individual temperature sensors, sensor matching, input offsets, and calculations).

2.5 THERMOWELLS

A. ½" NPT brass wells with junction box

2.6 BTU METER

A. The Btu meter shall provide the following points both at the integral LCD and as outputs to the building control system:

1. Energy Total
2. Energy Rate
3. Flow Rate
4. Supply Temperature and Return Temperature.

B. Output signals shall be serial network (protocol conforming to BACnet® MS/TP, BACnet/IP).

C. Meter shall be furnished with an integral alphanumeric liquid crystal display with a minimum of 16 alpha character (0.2" high) resolution and 6 numeric character (0.4" high) resolution.

D. Meter shall be furnish with an integral, non-volatile EEPROM memory for retention of all program parameters and totalized values in the event of a power loss.

E. Each Btu meter shall be factory programmed for its specific application, and shall be re-programmable using the front panel keypad (no special interface device or computer shall be required).

F. Accuracy:

1. Differential temperature within +/-0.15 deg. F. over calibrated range
2. Computing non-linearity within +/-0.05%

PART 3 - EXECUTION

3.1 INSTALLATION

A. Flow Meter

1. The flow meter shall be installed either in the supply or return pipe of the system to be measured.
2. Install per the manufacturer's instructions with particular attention to upstream and downstream straight pipe runs.

B. BTU Meter

1. Fasten meter to nearest wall, at approximately 5'-0" above finished floor.
2. Install per NEC

C. Temperature Sensors and Thermowells

1. Install thermowells in supply and return piping as indicated on the drawings and per the manufacturer's installation instructions.

3.2 CONNECTIONS

A. Piping

1. Prepare flanged connections in piping system to accept installation of hydronic energy meter.
2. Securely bolt meter in place, utilizing appropriate flange gasket material.
3. Tighten bolts to torque range as recommended by the meter manufacturer.
4. Allow, at a minimum, the manufacturer's straight pipe diameters upstream and downstream of the meter.
5. Install temperature sensors in thermowells per sensor manufacturer's installation instructions.

B. Controls

1. Terminate control wiring as recommended by the meter manufacturer and per the NEC.

END OF SECTION 23 93 50

SECTION 23 95 10
GENERAL PROGRAMMING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. The other Specifications of this Division complement the requirements of this Section.

1.2 SCOPE

A. This Section specifies requirements for the purchase, installation, configuration, and implementation the Building Automation and Integration system.

B. Provide all materials, equipment, labor and supervision necessary to install and perform all Control work described in this Section.

1.3 DEFINITIONS

A. DDC - Direct Digital Control

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide Shop Drawings, per requirements of Section 23 01 10.

B. Operation and Maintenance (O&M) Manuals:

1. Provide manuals, per requirements of Section 23 01 40.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Provide all programming, graphic design, and point mapping to provide a fully functional and completed system to the Owner.

3.2 COORDINATION

A. Coordinate final graphic layout with Owner.

3.3 SEQUENCES OF OPERATION

A. Program each Niagara Framework Network Controller, and third-party ASC, PCU, device, etc., to perform the sequences of operation provided on the construction documents Provide all necessary hardware on each piece of equipment in order for the equipment to perform the specified sequence and to meet the requirements of the point lists.

B. The Contractor shall be responsible for all control wiring connections, auxiliary devices and control wiring diagrams to complete the control system and attain the described sequence of operation.

3.4 GRAPHICS

A. Graphical representation of controlled/monitored systems shall be developed by the Control Contractor.

B. Graphics shall be customized to the facility.

C. The graphics shall, at a minimum, provide the user the following pages with the following data/functionality:

1. Overview page
    a. Summary of current operation including:
        1). Overall building status (occupied/unoccupied) if applicable
        2). Number of current alarms
        3). Outside air temperature and relative humidity
    b. Provide links to:
        1). Floor Plan Pages
        2). Alarm Page
        3). System Pages
2. Floor Plan Pages (for each level of the facility). Pages shall divided such that required information may be clearly presented.
    a. Floor plan representation of the facility, with major pieces of equipment.
        1). User shall be graphically alerted to any equipment that is in a "critical alarm" condition.
    b. Representation of Temperature Control Zones including
        1). Status (Occupied/Unoccupied), if applicable
        2). Temperature and humidity setpoints
        3). Actual zone temperature and humidity, with color coded indication of off-normal conditions.
        4). Links to Zone Pages
    c. Alarm Summary
        1). Text summary of all alarms present for equipment/zones shown on page.
3. Alarm Page
    a. List of all alarms with the ability to sort by:
        1). Active vs. Inactive alarms
        2). Severity level of alarm
        3). Area with in the building associated with the alarm
        4). System associated with the alarm
        5). Time/day of alarm occurrence
4. System Pages
    a. For each major controlled system, provide a page that summarizes the operation of the system.
    b. Include a system diagram will all control and controlled devices and components clearly identified.
        1). User shall be graphically alerted to any equipment that is in a Critical or Emergency Alarm condition.
        2). Diagram shall display status of equipment.
        3). Diagram shall display reporting value of all sensors, transducers, and switches associated with the system.
        4). Diagram shall display the position of all control valves and dampers associated with the system.
    c. Links to Equipment Pages

d. Link to balance report associated with the system, if applicable.

5. Zone Pages (for each Temperature Control Zone)
   a. Summary of setpoints associated with the Zone.
   b. Summary of actual Zone Operating conditions.
   c. Link to System Page(s) associated with the Zone.
   d. Link to trend data associated with the Zone.
6. Equipment Pages (For each piece of integrated or controlled equipment)
   a. Summary of setpoints associated with the Equipment.
   b. Summary of actual Equipment Operating conditions.
   c. Summary of alarms associated with the Equipment.
   d. Link to electronic copy of Approved Shop Drawings associated with the equipment, if applicable.
7. Energy Metering Page
   a. Display information as outlined in Energy Metering Section below.

3.5 ALARMS

A. System shall allow the Owner to configure alarm routing based on the following (at a minimum)
   1. Time of day
      a. Include functionally for interfacing with staff schedules.
   2. System type
   3. Alarm Class (see below)
   4. Location of device in alarm

B. System shall have the capability to route alarms in any of the following ways (or any combination thereof):
   1. Alarm to Graphic Screen
   2. E-mail
   3. Text Message
   4. Output to dedicated printer.

C. See Graphics requirements above for Alarm Graphic Requirements.

D. All alarms shall be stored by the System for a period of time adjustable by the Owner.

E. Alarm Classes
   1. All alarms shall be given a class as defined below. Controls Contractor shall be responsible for assigning Alarm Class.
      a. Mechanical - Attention required to ensure safe and efficient operation of mechanical systems.
      b. Electrical - Attention required to ensure safe and efficient operation of electrical systems.
      c. Critical - Abnormality that requires attention. Failure to resolve could lead to damage to equipment or property.

d. Emergency - Abnormality that requires immediate attention. Failure to resolve situation is a life safety issue, or could cause immediate damage to equipment or property.

e. Normal - All alarms shall be routed to this class.

2. System shall allow the Owner to configure new alarms, and to adjust settings and/or class of new alarms.

F. Configuration:

a. Controls Contractor shall configure alarm routing for 10 users.

3.6 TRENDS AND LOGS

A. System shall allow the Owner to perform a Trend of any digital or analog input or output used by the system for control or monitoring. The system shall allow the owner to configure the following for each trend (at a minimum):

1. Start time

2. Stop time

3. Sample rate

B. System shall allow the Owner to configure Trends of any digital or analog input or output used by the system for control or monitoring in a continuous (rolling) manner. The system shall allow the owner to configure the following for each continues trend (at a minimum):

1. Sample rate

2. Number of samples to save

C. System shall allow the Owner to export trend logs in .csv, and/or HTML format for external data analysis and review.

3.7 INTEGRATION

A. General

1. At a minimum, the points outlined in the specification below and/or indicated on the drawings shall be integrated for each piece of equipment. Additional points shall be integrated as required to successfully implement the Sequence of Operations.

2. Operational, Alarm, and Fault Codes from the equipment manufacture shall be integrated into the BAS system. The Bas system shall automatically compare the alpha-numeric code with a table and return the text description to the Building Engineer.

B. Communication Protocols

1. Field Control Network (FCN) integration protocol shall be as specified below. Controllers shall natively communicate via the following specified protocol without the use of any translators or gateways.

a. BACnet MS/TP (ASHRAE 135-2010)

2. Manufacturer-furnished Equipment Controllers

a. BACnet MS/TP (ASHRAE 135-2010)

b. ModBus

C. This contractor shall integrate the following manufacturer provided equipment controllers into the new automation system as follows:

1. Air handling units

2. Rooftop units

3. Variable frequency drives
4. Existing Boilers

D. This contractor shall also integrate the following special control systems into the new automation system:

1. Laboratory control system
2. Autopsy control system

3.8 SYSTEM SECURITY

A. System shall have multiple security levels to grant users differentiating levels of access. The levels shall be, at a minimum:

1. Level One - Read access only
2. Level Two - All previous levels, modify space temperature setpoints
3. Level Three - All previous levels, modify system setpoints
4. Level Four - Full access

END OF SECTION 23 95 10

SECTION 23 99 10
SEQUENCES OF OPERATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. The other Division 23 Specifications complement the requirements of this Section.

1.2 SCOPE

A. This section defines the required operational sequences and characteristics of mechanical equipment.

B. Sequences of operation are hereby defined as the manner and method by which controls function. Requirements for each type of control system operation are specified in this Section.

C. The Controls Contractor (CC) – also called the Temperature Controls Contractor (TCC) shall provide all necessary sensors, programming, testing, adjusting, devices, materials, labor, etc., to facilitate implementation of these sequences of operation.

D. Operating equipment, devices and system components required for control systems are specified in other Division 23 Sections of these specifications.

1.3 SUBMITTALS

A. The Controls Contractor shall include written sequences of operation in the Controls Submittals. The Controls Contractor shall modify the sequences to accurately reflect any changes made to the Engineer's sequences during the vendor's detailed design of the temperature control system.

PART 2 - SEQUENCE OF OPERATION

2.1 GENERAL

A. Control sequences are outlined in a flow/logic diagram format. This is understood to be a representation of the system operation, and not a programming flow chart. The controls contractor is responsible for all programming required to implement the sequences outlined below.

B. The CC shall coordinate all programming with the Owner. The CC shall review with the Owner all final control parameters (times, temperature, setpoints, etc.) prior to the completion of the project programming.

C. All setpoint values shown herein shall be adjustable, and shall utilize a named variable for simplicity in future modifications.

2.2 LEAD/STAND-BY OPERATION

A. Lead/standby operation shall be understood that only one piece of equipment operates at a time, with the other equipment is off. Upon failure of the lead equipment, the standby equipment shall be activated and become the lead. All such rotations shall generate an alarm.

2.3 ALARMS

A. General:

Table 1: Alarm Levels

Alarm Level	General Description	Action
Low	Maintenance item that does not require immediate intervention	Report to alarm graphic screen (unit/system and main alarm screen)
Medium	Response is needed to provide proper operation of equipment	
High	Timely response is needed to prevent facility or equipment damage or loss of system control.	Report to alarm graphic screen (unit/system and main alarm screen) Email selected recipients

2.4 PACKAGED CONSTANT VOLUME ROOFTOP UNITS (RTU-1,2,3,4)

A. General:

1. Each RTU is designed as a variable volume, constant temperature (with discharge temperature reset capability) unit.
2. The RTU is equipped with factory controls. The BAS shall provide the following control and monitoring functions of the unit's factory controls.

B. Occupancy Schedule

1. General
   a. The TC system shall provide Occupied/Unoccupied control of the unit based on a user-defined occupancy schedule and system conditions.
   b. Work with the Owner's designated operations personnel to finalize occupied and unoccupied times. Times indicated below are suggestions only. All schedules shall be fully adjustable.

System	Occupied	Unoccupied
RTU-1,2,3,4	6am – 7pm	7pm – 6am

2. Occupied:
   a. The OA damper shall be open.
   b. The relief air damper shall be open.
   c. The bypass damper shall be closed.
   d. The unit shall be controlled to maintain supply air temperature set-point.
   e. The unit shall be controlled to maintain supply duct static pressure set-point.
3. Unoccupied:
   a. The OA damper shall be closed.
   b. The relief air damper shall be closed.
   c. The bypass damper shall be open (full recirculation mode).
   d. The unit shall be controlled to maintain supply air temperature set-point.
   e. The unit shall be controlled to maintain supply duct static pressure set-point.

C. Initial Set-points:

1. All set-points listed below are general recommendations and should be reviewed with the Owner prior to implementation.
2. Operating parameter values shall be revised once the system is operational during the tuning and contractor commissioning phase of the project to ensure smooth and reliable system operation and to optimize system energy consumption.
3. All set-point values and limits values shall be adjustable through the BAS front end terminal.
4. Control Parameter Set-points
    a. Supply Air Temperature: 54°F
    b. Supply Duct Static Pressure: 1.0" w.c.

D. Supply Air Temperature Control

1. Supply Air Temperature Reset:
    a. The TC system shall monitor the supply VAV box mode for all boxes served by this RTU.
    b. The TC system shall monitor the supply VAV box reheat coil control valve positions for all boxes served by this RTU.
    c. The TC system shall monitor the supply VAV box primary air damper positions for all boxes served by this RTU.
    d. The TC system shall impose limits for adjusting supply air temperature above or below set-point. Suggest +7 deg and -4 deg. Set-point reset limits shall be adjustable.
    e. Heating Mode Reset:
        1). When the rooftop unit is operating in heating mode, the supply air temperature shall be reset up (warmer supply air temperature set-point) if any of the following are met:
            a). If most VAV boxes served by this RTU are in heating mode, the supply air temperature set-point shall be incremented up until at least one VAV box goes into cooling mode.
            b). If most VAV boxes served by this RTU have their reheat coil control valves at least 50% (adjustable) open, the supply air temperature set-point shall be incremented up until at least one VAV box closes its reheat coil control valve.
    f. Cooling Mode Reset:
        1). When the rooftop unit is operating in cooling mode, the supply air temperature shall be reset down (cooler supply air temperature set-point) if any of the following are met:
            a). If most VAV boxes served by this RTU are in cooling mode, the supply air temperature set-point shall be incremented down until at least one VAV box indexes its primary air damper to minimum cooling position.
            b). If any VAV box enters heating mode, the supply air temperature shall be reset up.
2. Supply Duct Static Pressure Reset

a. Static pressure set-point shall be reset based on worst case VAV box damper position.

b. The supply duct static pressure set-point shall be indexed down (less positive pressure) until the worst case space's VAV box is greater than or equal to 80% (adjustable) open.

c. When worst case space VAV box damper opens further than 95% (adjustable) to attempt to satisfy space temperature set-point, then the supply duct static pressure set-point shall be indexed until up (higher positive pressure) until worst case VAV box is less than 95% open (adjustable).

E. System Safeties

1. RTU shall be equipped with the following system safeties. All safeties shall shut down its respective system.

a. Supply and return air smoke detection

b. Supply fan high and low static pressure

2. Smoke Detection Shut Down

a. When smoke is detected at the duct smoke detector, the fire alarm system shall open a set of dedicated fire alarm contacts and shut down the entire Rooftop Unit with a hard-wired interface to the supply fan variable frequency drive.

b. The hard-wired fan shut down shall also cause all damper actuators to index to their fail-safe positions.

c. When the TC system detects a fan shut down (loss of fan status), the TC system shall also shut the fans off and configure damper positions and control outputs for a coordinated restart when the safety clears.

3. Static Pressure Shut Down

a. When the TCS detects a static pressure safety trip or fan shut down, the TCS shall shut the fans off and configure the control outputs for a coordinated restart when the safety clears.

b. The hard-wired fan shut down shall also cause all dampers to index to their fail-safe positions.

c. The static pressure safeties are Manual Reset. When the TCS detects a static pressure safety trip the TCS shall record the trip.

F. Unit Monitoring

1. General:

a. The TC system shall accumulate run times for each unit.

2. Safeties

a. The TC system shall monitor all system safety devices.

3. Pressure

a. The TC system shall differential pressure sensors across each filter bank and provide filter status soft-point by comparing actual filter bank differential pressure to the alarm set-point value (adjustable).

4. Status

a. The TC system shall monitor the supply fan status.

G. Alarms

1. General:
    a. The TC system shall report any detected sensor, component or actuator failure.
    b. The TC system shall accept alarm limits for the following sensors and provide an operator notification if they exceed user defined alarm limits.
        1). Temperature
        2). Humidity
        3). Pressure
2. Alarm Conditions
    a. Temperature:
        1). If the supply fan has been running for more than 5 min (adjustable), the TC system shall signal an alarm when the supply temperature is 2°F (adjustable) above or below the set-point.
        2). The TC system shall signal an alarm anytime the mixed air temperature is below 40°F.
    b. Pressure
        1). When the supply fan is running for more than 5 min. (adjustable) the TC system shall signal an alarm when supply duct static pressure is 0.5" w.c. above or below set-point.
        2). The TC system shall accept alarm limits for building static pressure and provide an operator notification if it exceeds user defined alarm limits.
        3). The TC system shall and record a "dirty filter warning" whenever any filter has a pressure drop exceeding its set-point.
    c. Safeties
        1). The TC system shall generate an alarm whenever any safety circuit device has tripped.
    d. Command Signal
        1). The TC system shall generate an alarm whenever a fan is not responding correctly to the control signal.
        2). The TC system shall monitor cooling coil UV emitter array status and signal an alarm if monitored status doesn't match the command signal status.

2.5 BOILER PLANT AND DISTRIBUTION PUMPS

A. General
    1. The heating water system consists of three (3) hot water boilers, three (3) primary pumps, and two (2) secondary heating water pumps.
    2. The system shall be DDC controlled with electric actuation.
    3. All suggested set points and settings shall be adjustable.
    4. The boilers will have a minimum on/off time of 5 minutes to prevent short cycling.

B. Initial set-points:

1. All set-points listed below are general recommendations and should be reviewed with the owner prior to implementation. Operating parameter values shall be revised once the system is operational during the tuning and contractor commissioning phase of the project to ensure smooth and reliable system operation and to optimize system energy consumption.
2. All set-point values and limit values shall be adjustable through the BAS front end terminal.
3. Operating parameter set-point values:
   a. Boiler enable: all times.
   b. Heating water supply temperature:
      1). Heating water supply temperature shall be reset by the BAS. Heating water supply temperature shall be inversely proportional to the outside air temperature in accordance with the following (adjustable) schedule. Outside air temperature shall be measured for the heating plant via a dedicated temperature sensor wired directly into the heating plant controller.

O.A. Temperature	Heating Water Supply Temp (deg F)
20	140
60	120

C. Plant enable/disable
1. The heating water system enable point shall be controlled either manually by the building operator or by a program function (i.e., outdoor temperature) of the BAS.
2. If the heating water system enable point is on and the outside air temperature is below 60 degrees f. (adjustable), the plant shall be enabled.

D. Plant start-up
1. The lead boiler's isolation valve shall be opened.
2. Once the boiler's isolation valve proves open, the lead primary heating water pump shall be started. Should the lead pump fail to start, the BAS shall close the boiler's isolation valve and index to the next pump and boiler and shall send an alarm. If a primary pump has failed, the BAS shall prohibit the boiler from operating.
3. Once the lead primary pump has started, the lead secondary heating water pump shall be started. Should the lead secondary pump fail to start, the BAS shall index to the next pump and shall send an alarm.
4. After heating water flow is proven through the lead boiler's flow switch and after a time delay (1 min., adjustable), the lead boiler shall be enabled.
5. The initial start-up firing rate shall be set to 25% (adjustable).
6. After running status has been proven for 2 minutes (adjustable), the boiler shall be released to operate under its own operating and safety controls to maintain a heating water temperature set-point of 180 degrees f. (adjustable). At this time, the boiler shall be permitted to decrease to a minimum run fire rate of 18% (adjustable).

E. Plant operation
1. Primary heating water pump control
   a. Primary heating water pumps are constant speed (constant volume).
   b. Primary pumps are dedicated to their associated boiler.

2. Secondary heating water pump control
    a. There are two (2) secondary heating water pumps.
    b. The system is designed to only require one (1) secondary pump in operation at any time.
    c. The order in which pumps are engaged shall be rotated weekly to equalize run time.
    d. The lead pump shall be brought on first, upon start-up of the plant.
    e. The pump speed shall be modulated to maintain the heating water differential pressure set-point.
    f. The BAS shall measure differential pressure and shall control based on the reading.
3. Boiler staging
    a. Once the lead boiler's firing rate reaches 100% (adjustable) and the heating water temperature set-point still cannot be maintained for a minimum of 10 minutes (adjustable), the BAS shall start the second boiler.
    b. The second boiler shall start its associated primary heating water pump.
    c. When the lag boiler starts, both boilers' modulation will be held at half of the lead boiler's modulation for 5 minutes (adj.).
    d. Both boilers will then modulate together between minimum fire and 100% to maintain the hot water supply set point.
    e. Once the load drops to a point where both boilers are running in tandem at a firing rate commensurate with 20% (adjustable) of their full load capacity for 10 minutes (adjustable), the BAS shall shut off the second boiler.
    f. After a time delay (5 min., adjustable), the second boiler shall shut off the its associated primary pump.
    g. The first boiler shall remain operational and shall adjust firing rate to pick up the entire building load.

F. Plant shut-down
1. The lead boiler shall be disabled
2. The secondary pump shall be shut off after a time delay (5 minutes, adjustable)
3. The primary pump shall be shut off after a time delay (8 minutes, adjustable).

G. Monitoring and alarming:
1. General
    a. The TC system shall accumulate run hours for the boiler.
    b. The TC system shall accumulate run hours for each distribution pump.
    c. The BAS shall monitor system temperatures and shall report an alarm if a sensor goes out of range (failed sensor).
    d.
2. System:
    a. Heating water supply and return temperatures shall be monitored by the BAS.
    b. Heating water supply and return temperatures at the boiler shall be monitored by the boiler's factory controller.

3. Boilers:

   a. A BACnet interface shall be provided for each boiler controller to communicate with the BAS.

   b. The BAS shall monitor a generic alarm point from the boiler. Upon receipt of a boiler alarm, the boiler shall go through a shutdown sequence.

   c. The operating status of the boiler shall be determined by the BAS monitoring the start/stop point, alarm point and the heating water supply temperature.

4. Pumps:

   a. Each variable frequency drive (secondary heating water pumps) shall be integrated into the BAS.

   b. The BAS shall monitor pump operation and shall generate an alarm if status deviates from enable/disable command signal status.

2.6 SERIES FAN POWERED TERMINAL BOXES

A. General

1. Each DDC (Direct Digitally Controlled) air terminal box controller (TBC) shall communicate with the Building Automation System (BAS) network.

2. Terminal box controllers shall be tied into the Building Automation System's local area network. Each TBC shall enable the BAS operator to monitor space temperature, discharge temperature, box fan status, coil control valve position and air volume. The BAS operator may adjust set points and limit the manual adjustment range of room sensor.

B. CO2 Monitoring:

1. Refer to controls floor plans for spaces with carbon dioxide sensors.

2. Terminal box controllers with local carbon dioxide monitoring shall:

   a. Report CO2 levels through the BAS system for demand control ventilation of the associated AHU outside air damper minimum position. And:

   b. Allow the box primary airflow damper to modulate to the lowest controllable airflow of SFPB (based on SFPB size) to maintain a CO2 level of 600 PPM.

C. Occupied Mode

1. Terminal box fan shall be energized and run continuously.

2. A room temperature sensor shall, through the terminal box controller, modulate the DDC air terminal box damper and normally open, electric heating water reheat coil control valve in sequence to maintain room set point requirements.

   a. For cooling, the air terminal box damper shall modulate between the scheduled minimum and the scheduled maximum CFM with the reheat coil control valve remaining closed to maintain occupied space temperature set point. If space CO2 is monitored, the box damper shall modulate between closed and the scheduled maximum CFM to maintain occupied space temperature setpoint.

   b. For heating, the air terminal box damper shall modulate to the scheduled minimum CFM and the reheat coil control valve shall modulate to maintain occupied space temperature set point.

   c. Refer to schedule to determine which terminal units have three-way or two-way re-heat coil control valves.

D. Unoccupied Mode – As scheduled through the BAS:

1. For fan powered terminal boxes served by air handling units (AHU's) that go into an unoccupied mode of operation (at night or on weekends) allowing the AHU to shut off with unoccupied setback and unoccupied setup temperature adjustments, the space temperature "drift points" shall be set to 8°F (adjustable) above and below occupied space temperature set point.
2. Unoccupied setback temperature shall be maintained by the TBC energizing the box fan and modulating the reheat coil control valve.
3. Unoccupied setup temperature shall be maintained by the TBC, through the BAS, energizing the air handling unit and modulating the fan box damper with the reheat coil control valve closed.

E. Unoccupied Mode (As Determined By Space Occupancy Sensors)

1. If during normal hours (with the AHU running) a space occupancy sensor determines the space is unoccupied, the TBC shall close the primary air damper to its minimum controllable airflow position, and modulate the reheat coil control valve to maintain space temperature 2°F above or below set point. The box fan shall run continuously during this mode.
2. Occupancy sensor shall be provided by the Electrical Contractor and shall also be interlocked with the room lights.
3. Refer to electrical lighting floor plans for occupancy sensor(s).

2.7 GENERAL EXHAUST FANS

A. General

1. Each DDC (Direct Digitally Controlled) fan controller (TBC) shall communicate with the Building Automation System (BAS) network.
2. Fan controllers shall be tied into the Building Automation System's local area network. The BAS operator may adjust set.

B. Roof Mounted Exhaust fans shall be energized by the BAS and shall operate continuously during occupied hours in junction with the associated RTU. Fan status shall be monitored by the BAS via a circuit sensing relay.

C. Where motor operated isolation dampers are called for, the BAS shall drive the damper open upon a call for the fan to operate. The damper shall be closed when the fan is not operating.

2.8 HYDRONIC AND ELECTRIC CABINET UNIT HEATERS

A. Upon a call for heating from a remote 24V thermostat, a 24 volt heating water control valve shall open and the unit fan shall be energized. When heating is no longer required, the fan shall be de-energized and control valve shall close. Thermostat shall be furnished, installed and wired by the Temperature Controls Contractor. Control valve shall be furnished and wired by Controls Contractor, installed by Mechanical Contractor.

2.9 HYDRONIC UNIT HEATERS

A. Upon a call for heating from a remote 24V thermostat, a 24 volt heating water control valve shall open and the unit fan shall be energized. When heating is no longer required, the fan shall be de-energized and control valve shall close. Thermostat shall be furnished, installed and wired by the Temperature Controls Contractor. Control valve shall be furnished and wired by Controls Contractor, installed by Mechanical Contractor.

2.10 HYDRONIC PANEL RADIATORS

A. Hydronic panel radiators shall be controlled on a reset schedule based on outside air temperature (OAT).

B. A two-way modulating control valve serving each radiator shall modulate flow to the radiators per the following adjustable reset schedule (schedule shall be linear):

1. When OAT is 50°F, valve position shall be 0% open.

2. When OAT is 0°F, valve position shall be 100% open.

2.11 DX DUCTLESS SPLIT SYSTEMS

A. Space temperature shall be maintained by a remote sensor cycling the condensing unit on/off. DACU fan shall run upon a call for cooling and cycle on/off in sequence with associated condensing unit. The DACU space thermostat shall be set 2°F higher than the redundant series fan-powered box space temperature sensor (if applicable – refer to temperature controls floor plans), such that the DACU only operates during AHU unoccupied periods.

B. Remote temperature sensor shall be furnished by DACU manufacturer; installed and wired by the Controls Contractor.

C. Space temperature shall be monitored by the BAS via separate space temperature sensor. If spaces temperature rises to 80°F, the BAS shall alarm the building operator.

D. The BAS shall monitor the DACU via BACnet.

E. The DACU shall have a hard-wired general alarm in the BAS.

2.12 ELEVATOR PIT SUMP PUMP - SUMP LEVEL MONITORING

A. A fluid level sensor in the sump shall alarm the BAS control panel when the liquid level is too high. High level sensor is furnished by the sump pump manufacturer.

B. The BAS shall also monitor and alarm whenever the pump is energized.

2.13 MECHANICAL ROOM VENTILATION

A. A room temperature sensor shall energize the ventilation exhaust fan when space temperature exceeds set point.

B. Whenever the ventilation fan is energized to operate, the normally closed outdoor air damper and normally closed exhaust air damper shall open.

C. Fan may also be manually energized by the room occupant (with both dampers opening) via the wall-mounted motor starter switch.

2.14 FIRE PUMP ROOM VENTILATION

A. A room temperature sensor shall energize the ventilation exhaust fan when space temperature exceeds set point.

B. Whenever the ventilation fan is energized to operate, the normally closed outdoor air damper and normally closed exhaust air damper shall open.

C. Fan may also be manually energized by the room occupant (with both dampers opening) via the wall-mounted motor starter switch.

2.15 ELECTRICAL ROOM VENTILATION

A. A room temperature sensor shall energize the ventilation exhaust fan when space temperature exceeds set point.

B. Whenever the ventilation fan is energized to operate, the normally closed outdoor air damper and normally closed exhaust air damper shall open.

C. Fan may also be manually energized by the room occupant (with both dampers opening) via the wall-mounted motor starter switch.

2.16 FUME HOOD EXHAUST FAN

A. The fume hood exhaust fan shall be started and stopped by a manually operated toggle switch located on the face of the fume hood.

B. The fan shall be equipped with a motorized isolation damper which shall open when the fan is energized and close when the fan is de-energized.

2.17 DOMESTIC WATER BOOSTER PUMP

A. General

1. Duplex domestic water booster system shall be furnished with integral controller and human machine interface (HMI) that is compatible with BAS via BACnet integration.

2. BAS shall monitor the following: system flow, system pressure, set point, suction pressure, pump status (on/off), and individual VFD Hz, Volts, Amps, and kW.

2.18 DOMESTIC HOT WATER SYSTEM

A. General

1. Each DDC (Direct Digitally Controlled) fan controller (TBC) shall communicate with the Building Automation System (BAS) network.

2. Fan controllers shall be tied into the Building Automation System's local area network. The BAS operator may adjust set.

B. Water Heater Operation

1. Upon a call for heating, as sensed thru the semi-instantaneous domestic hot heater, the semi-instantaneous domestic hot heaters shall modulate fire to maintain discharge domestic hot water temperature. Domestic hot water discharge temperature setpoint shall be controlled by the BAS and shall be set to 140°F.

2. Each boiler’s control panel shall be provided with a BACnet interface for extension to the Building Automation System control panel. This interface shall allow the operator to remotely review status, enable/disable the boilers and change set points, including set point temperatures and time-clock functions such as start-up/shut-down times.

3. The domestic hot water supply temperatures in both the 120 deg loop and the 140 deg loop shall be monitored by the BAS thru a separate field installed temperature sensor. The BAS shall alarm if supply temperature drops below 110°F and 130°F respectively.

C. Domestic Hot Water Re-circulating Pump Operation (RP-1,2):

1. The recirc pump shall start/stop thru the BAS to maintain a recirc hot water temperature of 115°F and 135°F respectively.

2. The BAS shall monitor pump status and generate an alarm whenever a pump is not responding correctly to the control signal.

2.19 GENERATOR INTERFACE

A. The BAS system shall monitor the generator's operation via a BACnet integration to the generator's onboard controller.

B. The BAS system shall monitor the status of the emergency generator automatic transfer switches via the auxiliary contact that is furnished by the Automatic transfer switch manufacturer.

C. The TCC shall run the necessary network cabling out to the outdoor generator via an underground conduit furnished by the EC. The EC shall make final wire connections.

2.20 HYDRONIC ENERGY METERS

A. The BAS system shall monitor the heating plant hydronic energy meter via a BACnet integration to the meter.

B. The BAS shall record total and peak energy consumption on a daily basis.

2.21 NATURAL GAS SUB-METERS

A. The BAS system shall monitor the natural gas sub-meters via a BACnet integration to each meter.

B. The BAS shall record total and peak gas consumption on a daily basis.

2.22 ELECTRIC SUB-METERS

A. The BAS system shall monitor the electric sub-meters via a BACnet integration to each meter.

B. The BAS shall record total and peak electric consumption on a daily basis.

C. The TCC shall run the necessary network cabling to each electric meter for final wire connections by the EC.

2.23 GREENHOUSE CONTROL SYSTEM

A. General

1. This sequence shall be provided under bid alternate no. G-1.

2. The greenhouse controller shall be integrated into the BAS for monitoring and alarming.

B. The TCC shall furnish a dedicated greenhouse controller which shall control the following components. The controller shall be equivalent to a Link4 Corp. iGrow 800 series controller.

1. Greenhouse motorized wall panels and ridge vent panels

2. Two (2) gas-fired unit heaters

3. Two (2) propellor type exhaust fans

C. Space Heating

1. The space temperature shall be maintained at 50°F (adjustable) in the winter.

2. The controller shall cycle the gas-fired unit heaters to maintain space temperature setpoint.

D. Space Ventilation.

1. When the space temperature exceeds 80°F (adjustable) the controller shall open the side and ridge vents.

2. If the temperature exceeds 85°F (adjustable), the controller shall close the ridge vent and start the propellor exhaust fans.

2.24 OUTDOOR AND INDOOR LIGHTING INTERFACE

A. The BAS shall interface with the lighting control panels (for indoor and outdoor lighting) to turn the lights off and on at programmed/scheduled time intervals via digital output from BAS. Refer to controls floor plans for location of lighting panels.

END OF SECTION 23 99 10

SECTION 26 00 51-BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. The work shall include the furnishing of systems, equipment, and materials specified in this Division and as called for on the Drawings, to include: supervision, operations, methods, and labor for the fabrication, installation, start-up, and tests for the complete electrical installation.

B. Drawings for the work are diagrammatic, intended to convey the scope of the work and to indicate the general arrangement and locations of the work. Because of the scale of the Drawings, certain basic items such as conduit fittings, access panels, sleeves, pull and junction boxes may not be shown. Where such items are required by Code or by other Sections, or where they are required for proper installation of the work, such items shall be included.

C. Equipment Specification may not deal individually with minute items such as components, parts, controls and devices which may be required to produce the equipment performance specified or as required to meet the equipment warranties. Where such items are required, they shall be included by the supplier of the equipment, whether or not specifically called for.

1.3 ELECTRICAL REFERENCE SYMBOLS

A. Symbols used on the floor plans are defined in the Electrical Symbols Schedule on the Drawings. Not necessarily will all symbols scheduled be required for the project.

B. The symbols used for schematic or one line power and control wiring diagrams are American Standard Graphical Electrical Symbols and are published in American Standard Chart Z32.3.

1.4 PERMITS, INSPECTIONS, AND CODES

A. The Contractor shall secure and pay for all permits and inspections required by the governing authorities for the prosecution of the electrical work. All permits and certificates of inspection and approval signed by the controlling building department shall become the property of the Owner.

B. All wiring shall be in compliance with the current edition of the National Electric Code, applicable State and City regulations, and OSHA. In cases of conflict between Code and Specifications, the more restrictive requirements shall govern.

1.5 VISIT TO THE SITE

A. The Electrical Contractor shall be required to visit the site of the work and familiarize himself with all such conditions affecting the work. The submission of his bid proposal shall presuppose his knowledge of all such conditions.

1.6 WORKMANSHIP

A. Employ only experienced craftsmen under direct supervision of a full time competent foreman.

B. Keep fully informed as to progress of work, so that work of this Division may be built into place in sufficient time to insure against delay to other trades, and to prevent misalignments or damage to electrical work.

C. All work shall be completed in a neat and workmanlike manner as described and illustrated in the ANSI standards publication "*NECA 1-2000 Standard Practices for Good Workmanship in Electrical Contracting".*

1.7 COORDINATION, CONDUCT, AND SCHEDULING OF WORK

A. Electrical drawings are diagrammatic, indicating general arrangement, approximate sizes, general locations of equipment and outlets. Verify dimensions in field; adjust to manufacturer's shop drawings. Do not scale drawings.

B. Architectural and structural drawings supersede electrical drawings. Determine that work of this Division can be accommodated within spaces provided. Notify Construction Manager and/or Architect of any interferences before starting installation.

C. Determine sizes, locations for chases, openings necessary for installation of electrical work; cooperate with other trades in setting of sleeves, inserts, and hangers.

D. Coordinate this work with all trades, serving utilities, and equipment suppliers. Arrange operation, submittal approvals, and equipment delivery, so as not to delay installation or completion of any parts of interrelated work so that construction may proceed on schedule.

E. Cooperate with Mechanical trades in preparing interference drawings for points where there is possible conflict between trades. Exact locations of pipes, ducts, conduit based on field measurements with final arrangement to be determined by intra-trade agreements subject to Construction Manager's and/or Architect's review.

F. Architect reserves the right to make reasonable changes in indicated locations without extra cost to the Owner.

G. Drawings other than electrical drawings, and other sections of this Specification, may show or specify electrically operated equipment, wiring diagrams, etc. The Contractor shall examine all such drawings and specification sections and become familiar with the characteristics and required connections for all equipment.

H. Conduits, wiring, and equipment shall be arranged substantially as indicated. Any change resulting in a savings in labor or material shall be made only in accordance with a contract change order. Deviations shall be made only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted to and approved by the Architect.

I. Electrical Contractor shall coordinate and schedule all work to be provided by all electrical utility companies (AEP, CATV, Fiber, telephone, etc.).

1. All utility company charges shall be paid by owner and excluded from the Electrical Contractor's proposal.

2. Notify the electrical engineer of any/all discrepancies or deviations from that work shown on the bid documents prior to execution of work.

1.8 MATERIALS

A. All equipment and devices shall be new and shall conform to NEMA and Underwriters' Laboratories Standards. Where Specifications describe, or plans show, materials or equipment of higher quality than required by code and local ruling, the Drawings and Specifications shall govern the quality of the material or equipment.

B. Materials and equipment used as extensions to existing special systems shall be of matching electrical characteristics for satisfactory operation of the complete system and shall be of the same manufacture and design unless otherwise approved.

C. The Contractor shall submit proof, if requested by the Architect, that the materials, appliances, equipment or devices that he furnishes and installs under this contract, meet the requirements of the Underwriters' Laboratories, Inc. and its publications will be referred to hereinafter by the abbreviation UL, with or without additional identifying symbols.

D. The National Electrical Code (NEC) of the National Fire Protection Association, and Publications and Standards of the organizations listed below are referenced herein by the abbreviations noted in parentheses, with or without additional identifying symbols. Unless otherwise specified, all work shall be manufactured, tested and installed in accordance with such reference standards.

1. American Society for Testing and Materials (ASTM)
2. Underwriters' Laboratories, Inc. (UL)
3. Insulated Power Cable Engineers Association (IPCEA)
4. National Electrical Manufacturers Association (NEMA)
5. Institute of Electrical and Electronic Engineers (IEEE)
6. American National Standards Institute, Inc. (ANSI)
7. National Fire Protection Association (NFPA)

1.9 GUARANTEE

A. The Electrical Contractor shall guarantee for a period of one year that all work and equipment will remain free from all defects in workmanship and materials, and that it will comply with all the specific requirements of the Specifications and other Contract Documents governing the work.

B. All work found to be defective will be replaced with new work meeting all the requirements of the Contract. The Electrical Contractor will bear all costs of supplying such new work, and installing and finishing same, and will assume all costs for replacing other work damaged by the removal and replacement of any of the work. The Electrical Contractor will bear all costs for freight, drayage and demurrage, and all labor in connection therewith.

1.10 SUBMITTALS

A. This Contractor shall prepare or obtain from the manufacturer certified shop or erection drawings of the items listed below. After Contractor’s review and approval of the proposed submittal, electronic copies of each shall be stamped and submitted to the Architect for approval before proceeding with installation or construction.

1. All lighting fixtures shall be submitted at one time. These drawings shall be complete in every respect, showing pertinent details of size, capacities, ballasts, accessories, type and thickness of materials, weight, maintenance, features, etc.
2. Submittal drawings for all electrical distribution equipment identified with an asterisk " * " in paragraph 1.10B below shall consist of factory generated shop drawings only (submittals developed by local sales agencies or local distributors are not acceptable and will be returned without review). Factory submittals shall minimally include the following information;
    a. Dimensioned plan view and dimensioned elevations to define all sizes, shipping splits, rough-in areas, lifting eyes, mounting rails, required access, door swings, location of major components, etc.
    b. Complete description of all power bus including physical size, bus configuration, bus elevations, bus dimensions, bus material, bus bracing, bus ampacities, etc.
    c. Description of all materials (type and thickness), finishes, devices and accessories providing sufficient information (including a "bill-of-material" where applicable) to permit evaluation and determine compliance with Construction Documents.
    d. Control schematics (where applicable).

e. Wiring diagrams.

f. Three-line diagrams (15 KV, 5 KV Switchgear only)

g. Nameplate details and nameplate listing.

h. Mimic bus layout (where applicable).

i. Listing of all applicable listings and construction standards.

j. Additional information as noted in the individual specification section.

B. Approval drawings shall be submitted for the following items. Acceptable manufacturers shall be as described in the individual specification sections except where specifically noted below:

1. 26 00 56 - Firestopping
2. 26 01 14 - Cable Tray
3. 26 01 40 - Wiring Devices and Plates
4. 26 01 54 - Fractional Horsepower Motor Starters
   a. ABB/GE "CR101"
   b. Allen Bradley "Bulletin 600"
   c. Cerus "BAS-1P"
   d. Cutler-Hammer "Type MS"
   e. Siemens "Type SMF"
   f. Square D "Class 2510"
5. 26 01 55 - Combination Motor Starters
   a. ABB/GE "300 Line"
   b. Allen Bradley
   c. Cutler-Hammer
   d. Siemens
   e. Square D
6. *26 01 62 - Distribution Switchboards
   a. ABB/GE "Spectra AV Series"
   b. Cutler-Hammer "Pow-R-Line"
   c. Siemens "SB" Series
   d. Square D "Power-Style"
7. *26 01 64 - Circuit Breaker Distribution Panelboards
   a. ABB/GE "Spectra Series" or "EntellEon"
   b. Cutler-Hammer "Pow-R-Line 4B"
   c. Siemens "P5" Series
   d. Square D "I-Line"
8. 26 01 65 - Branch Circuit Panelboards
   a. ABB/GE "AQ/AE/AD Series"

b. Cutler-Hammer "Pow-R-Line"
c. Siemens "P2" Series
d. Square D "NQ/NF"

9. 26 01 70 - Disconnect Switches
   a. ABB/GE
   b. Cutler-Hammer
   c. Siemens
   d. Square D
10. 26 01 71 - Surge Suppression
   a. ABB/GE "Tranquell Series"
   b. Advanced Protection Tech. "XT Series"
   c. Current Technology "TG Series"
   d. Eaton Cutler Hammer/Innovative Technology "PTX Series"
   e. Siemens "TPS3 Series"
   f. Square D Surgelogic "XGA Series"
   g. Surge Suppression Inc. "Advantage" Series
   h. United Power "PDX Series"
11. 26 01 81 - Fuses
   a. Bussmann
   b. Littlefuse
   c. Mersen
12. *26 02 16 - Standby Power Generation
13. *26 02 50 - Automatic Transfer Equipment
14. *26 04 61 - Dry Type Distribution Transformers
   a. ABB/GE – 2016 DOE
   b. Acme Electric – 2016 DOE
   c. Cutler-Hammer – 2016 DOE
   d. Federal Pacific – 2016 DOE
   e. PowerSmiths – E-Saver 33L
   f. Siemens – 2016 DOE
   g. Square D – 2016 DOE
15. 26 05 01 - Lighting - General Description
16. 26 06 01 - Lightning Protection System
17. 26 09 16 - Lighting Control System
18. 26 09 32 - Automatic Lighting Controls

C. Electronic submittals shall conform to the following requirements:

1. Electronic submittals shall be in Portable Document Format (.pdf)
    a. Electronic submittals shall include a transmittal.
    b. All portions of the electronic submittal shall be bound in a single .pdf file.
    c. All content of the submittal shall be visible/readable and shall clearly indicate each item to be reviewed. Indicate specific options or accessories on shop drawings by pointing to, checking off, underlining, or other means.
    d. File shall be named to match submittal contents.
    e. Submittals shall include a specific notice of any deviation from the Contract Documents.
2. Electronic submittals shall include a Contractor review stamp that indicates review and approval by the Contractor prior to submission.
3. Electronic submittals shall be transmitted via an email.
    a. One submittal per email.
    b. Email shall clearly contain project name and contents of submittal.
4. Failure to conform to the requirements above may result in rejection.
5. The Reviewer shall return the submittals in a format and method appropriate for the Project and the response.

D. AutoCAD floor plans are available to Vendors and Contractors to assist in generation of shop drawings.

E. Prior to the signing of the contract the successful bidder shall submit to the Architect a list of manufacturers of the major items of equipment he proposes to furnish and the names of any subcontractors he proposes to employ.

1.11 ENGINEER'S REVIEW

A. Shop drawings shall be reviewed for general compliance. The Reviewer will make reasonable efforts to detect and correct errors, omissions and inaccuracies but shall not be responsible for failure to detect errors, omissions, or inaccuracies. Failure to detect errors, omissions, and inaccuracies shall not relieve the Contractor of responsibility for the proper and complete installation in accordance with the intent of the Contract Documents.

B. The Engineer shall mark the shop drawings in one of the ways outlined below. See each description for interpretation of Engineers marks and Contractor responsibilities associated with each.

1. APPROVED: The submittal complies with the requirements of the specifications.
2. APPROVED AS NOTED: The submittal generally complies with the requirements of the specifications but some non-critical items which need to be corrected/coordinated are noted. The corrections shall be changed on the shop drawings submitted for inclusion in the Operations and Maintenance Manual. Re-submittal is not required unless noted otherwise.
3. REVISE AND RESUBMIT: The submittal generally complies with the requirements of the specifications but some critical items which need to be corrected/coordinated are noted. The submittal must be revised and resubmitted with all comments addressed.
4. REJECTED: The submittal does not comply with the requirements of the specifications. The submittal must be revised and resubmitted.

C. Approval of submittal items shall not eliminate the Engineers right to reject those items if defects are discovered prior to final acceptance of the completed work.

1.12 SUBSTITUTION

A. Bidders desiring to make a substitution for the specified brand or method shall list such proposed substitution. In each case state the difference in price where substitution is offered. If there is no difference in price, so state.

B. It shall be understood that the proposal submitted shall be based on the different branches of work and materials specified, and that the Owner is entitled to the use of the materials so specified. Substitution sheet shall be signed and dated by the Electrical Contractor and shall be formatted as follows:

BRAND OR MAKE SPECIFIED | PROPOSED SUBSTITUTION | ADD | DEDUCT

1.13 APPROVED WIRING SYSTEMS

A. All raceways, conductors, and wiring systems furnished and installed under this project shall be restricted to that specifically described on the electrical construction drawings and/or the following Electrical Specification Sections.

1. 26 00 53 General Wiring
2. 26 01 11 Conduit Systems
3. 26 01 20 Wire and Cable

B. Unless specifically noted otherwise on the Electrical Bid Documents, the Electrical Contractor shall not install Type AC armored cable, Type FC flat cable, Type FCC flat conductor cable, Types NM / NMC / NMS nonmetallic sheathed cable, Types SE / USE service cable or Type UF underground feed cable. Refer to Specification Section 26 01 20 for the limited use of MC Cable.

1.14 CONCRETE WORK

A. Concrete bases and pads for electrical equipment identified on the Drawings or as required shall be the responsibility of this Section.

B. Pads shall be 3" high with chamfered top edges unless otherwise noted on the Drawings. Pad sizes and locations shall be determined by the Electrical Contractor (do not scale from the Drawings).

C. This Contractor shall furnish all equipment anchor bolts and shall be responsible for their proper installation and accurate location.

1.15 NAMEPLATES AND LABELS

A. The Electrical Contractor shall furnish and install a system of nameplates designed to identify each piece of equipment, control unit thereon, and major distribution points. The following color scheme shall be used as a guide:

1. For switchboards, panelboards, control centers, all panels and remote control and indicating devices served by "normal" power, use black plastic, laminated, with white engraved letters. For equipment served by "emergency" power, use red plastic, laminated, with white engraved letters.

a. Switchboard, distribution panelboard, branch circuit panelboard, and motor control center nameplates shall identify panel designation, voltage, and designation of upstream source:

1). Line 1: “Panel 1-2A”

2). Line 2: “208/120V, 3Ø, 4-wire”

3). Line 3: "Fed from switchboard SDP-2A"

2. For fire alarm system cabinet and panels, use red laminated plastic with white engraved letters.

3. For telephone distribution cabinets and panels, use black plastic with white engraved letters.

4. Size of nameplates shall be made to readily differentiate between, and identify, equipment and usage. Nameplate identifying items that are transferred to emergency power shall carry a nameplate saying "EMERGENCY".

5. Exposed feeder conduits shall be identified as to load fed and voltage (Normal or Emergency) with 1" high black stenciled letters and numerals; conduit shall be marked every 50 feet and at the supply end of the feeder. This shall include existing "spare" conduits.

B. Nameplates for switchboards and panelboards shall be as shown on the drawings and as required in accordance with NEC 408.4(B).

C. Fasten nameplates to all enclosures by use of stainless steel sheet metal screws.

D. A label reading "contains emergency circuits" shall be installed on all boxes and enclosures that contain emergency powered circuits to comply with NEC 700.9(A).

1. Labels shall be installed on front covers of all pullboxes, junction boxes, and control enclosures.

2. Labels shall be installed on interior trim of all branch circuit panelboards.

3. Labels shall be installed on front trim of each transfer switch.

E. The Electrical Contractor shall furnish and install Arc Flash Warning labels in a clearly visible location on the front trim of all switchboards, panelboards (inside the hinged panel cover), industrial control panels, meter socket enclosures, and motor control centers to comply with NEC 110.16. Labels shall be Brady Identification Solutions (1-800-537-8791) cat. no. 94913, 3.5" x 5", or equivalent.

1.16 PANELBOARD DIRECTORIES

A. New panelboards shall be provided with typed directories indicating loads served from each branch circuit. Existing panelboard directories shall be updated to reflect all new branch circuit wiring installed and existing branch circuit wiring removed.

B. Directories shall designate the type of load and room/area served.

1. The load description shall indicate receptacle, lighting, or fixed pieces of equipment. Portable equipment shall not be used to identify a branch circuit (i.e. coffee pot, fax machine, computer, etc.).

2. Room descriptions shall utilize the Owner's room numbers, not the architectural plan room numbers. Where no room number is assigned by the Owner, the description shall include the location and room usage (i.e. South Storage, Lounge, etc.).

3. Room numbers and descriptions shall be approved in advance by the Owner.

C. All unused branch circuit breakers shall be placed in the "off" position and the corresponding line on the directory shall be labeled "spare" with an erasable lead pencil.

1.17 CLEANING AND PAINTING

A. Touch up and repair any damaged factory finishes on equipment and materials furnished. Other painting will be done under the Painting Division of the Specifications.

B. Remove any rust spots and prime with rust inhibitive paint any metal surfaces of electrical devices not provided with rust inhibitive coatings. Then apply one coat of paint in color as directed by Architect.

C. Swab interiors of conduits clean and dry before pulling wire. Clean interiors of boxes and cabinets before installing trims and covers.

1.18 TESTS

A. Systems shall be tested by the Electrical Contractor and placed in proper working order prior to demonstrating systems to Owner.

B. After work is completed a load balance test shall be made by the Electrical Contractor to demonstrate that with full lighting and mechanical load the balance between phases is within 5%. Unbalance beyond this limit shall be corrected. Special care shall be taken during load balance adjustments to assure that reverse rotation of motors does not occur.

C. System ground shall be tested to demonstrate that the ground resistance does not exceed the requirements of NEC.

D. Perform such tests as required by authorities having jurisdiction over the site.

E. Perform tests as described in all subsequent specification sections.

1.19 DEMONSTRATIONS

A. Prior to acceptance of the work, the Contractor shall demonstrate to the Owner or his designated representative all features and functions of all systems and shall instruct the Owner in the proper operation of the systems. Each system shall be demonstrated once.

B. The demonstrations shall consist of not less than the following:

1. Point out the actual location of each component of a system and demonstrate its function and its relationship to other components within the system.

2. Demonstrate the electrical systems by actual "start-stop" operation showing how to work controls, how to reset protective devices, how to replace fuses, and what to do in an emergency.

3. Demonstrate communication, signal, alarm, and detection systems by actual operation of the systems and show how to reset signal, alarm, and detection devices.

C. Systems to be demonstrated shall include but not be limited to the following:

1. Service and Power Distribution Systems

2. Lighting and Lighting Controls Systems

3. Emergency Lighting Systems

4. Motor and Equipment Control

5. Standby Power System

D. Contractor shall furnish the necessary trained personnel to perform the demonstrations and instruction, and shall arrange to have the manufacturer's representatives present to assist with the demonstrations.

E. Contractor shall coordinate dates and times for performing all demonstrations with the Owner.

1.20 OPERATION AND MAINTENANCE MANUALS

A. Electrical Contractor shall furnish to the Owner operation/maintenance manuals as described in the Division 1 Specifications.

B. Manuals shall meet or exceed all Division 1 Specification requirements and shall minimally include three (3) individually bound and indexed (thumb tabbed) manuals. Each manual shall provide operating instructions, maintenance manuals, spare parts listing, copies of warranties, wiring diagrams, inspection procedures and shop drawings on all equipment and systems.

C. An electronic copy of the all manuals shall also be provided on CD or DVD. Each manual shall consist of a separate bound PDF file arranged in the same order as the associated hardcopy.

D. Unless otherwise directed by the Division 1 Specification each manual shall be bound in a heavy-duty, 3 inch, three-ring vinyl covered binder with pocket folders for drawings and folded sheet information. Each binder shall be identified on both the front and the spine.

1.21 AS-BUILT DRAWINGS

A. As work progresses during the construction period, the Electrical Contractor shall record (on a dedicated set of bid drawings) any deviations from the design drawings. The completed record set of as-built drawings shall be delivered to the Architect prior to the Electrical Contractor's request for final payment.

B. As-built documentation shall meet or exceed all Division 1 Specification requirements.

1.22 PROJECT CLOSE-OUT

A. The installing Contractor shall contact the Engineers' office upon completion of the installation to request final inspection. At that time the following documents shall be assembled and provided for review at the job site:

1. ☐ Photocopies of all branch panel schedules.
2. ☐ Original (or carbonless copy) of signed hazardous waste disposal receipt from approved disposal facility for the following (where applicable):
   a. ☐ PCB contaminated transformers
   b. ☐ Fluorescent and HID lamps
   c. ☐ Fluorescent and HID ballasts
3. ☐ Photocopies of all signed electrical inspection permits.
4. ☐ O & M Manuals (as described above).
5. ☐ Photocopies of certified test results, as required by all specification sections.
6. ☐ "As-Built" print set.
7. ☐ "As-Built" flexible manufactured wiring system drawings where installed (Specification 26 04 73).
8. ☐ Photocopy of the "spare fuse inventory" provided.
9. ☐ Photocopy of Printout from Fire Alarm System listing device addresses and custom labels.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION 26 00 51

SECTION 26 00 52-TESTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. It is the purpose of these specifications to assure that all tested electrical equipment, both contractor and owner supplied, is operational and within industry and manufacturers tolerances and is installed in accordance with design specifications.

B. The Electrical Contractor shall be responsible for the execution, coordination and supervision of all testing work required by these specifications and the authorities having jurisdiction.

C. Testing shall be performed by an independent testing agency as a Sub-Contractor to the Electrical Contractor.

1. The Electrical Contractor shall coordinate and schedule all work to be performed by the testing Sub-Contractor.

2. The Electrical Contractor shall supply to the testing organization complete sets of approved shop drawings, coordination study, settings of all adjustable devices, and other information necessary for an accurate inspection and evaluation of the system prior to the performance of any tests.

D. Cable or equipment testing failures that are not immediately correctible shall be included in the final report. These instances would include defective breakers, damaged cables and similar. Corrective action taken shall be outlined in the report and final successful testing results shall be provided.

1.3 CODES AND STANDARDS

A. International Electrical Testing Association - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems, latest revision.

B. All inspections and tests shall be performed in accordance with applicable codes and standards including NEC, ANSI, IEEE, NFPA, NEMA, and OSHA.

C. Equipment calibration program shall conform with the National Institute of Standards and Technology (N.I.S.T.).

D. All tests shall be in accordance with the latest edition of the International Electrical Testing Association's (NETA) Acceptance Testing Specification for Electrical Power Distribution Equipment and Systems.

1.4 QUALIFICATIONS

A. The contractor shall engage the services of a qualified independent testing organization to provide final inspection, testing, calibration, and adjusting on the electrical distribution system as defined in this specification.

B. The independent testing organization shall have been engaged in full practice for a minimum of five years. The organization shall be corporately and financially independent of the supplier, producer, or installer of the equipment to be tested.

C. Electrical testing shall be performed by Electrical Testing Services (440-327-0078), Great Lakes Testing (440-951-5861), High Voltage Maintenance Corporation (Donwil Company 877-373-6524), Independent Testing and Maintenance (330-753-1422), or another approved International Electrical Testing Association (NETA) certified testing agency.

1.5 SUBMITTALS

A. The Electrical Contractor and testing Sub-Contractor shall submit for approval an acceptance test procedure for each item of electrical distribution equipment to be tested on this project. Test procedures shall include the proposed system function test. No testing shall be performed until the test procedures have been approved by the Electrical Engineer.

PART 2 - TESTING PROCEDURE

2.1 VISUAL INSPECTION

A. An on-site visual inspection of the installed equipment shall be performed by the Testing Sub-Contractor to verify that the distribution equipment installed and to be tested is the equipment denoted on the approved shop drawings. The inspection shall check the equipment designations, device characteristics, special installation requirements, applicable codes, and standards.

B. After completion of the visual inspection, a letter shall be filed to the Architect stating any discrepancies that were found.

2.2 TESTING GUIDELINES

A. Switchboards: Perform all tests, including all optional tests, listed in section 7.1 of NETA ATS.

B. Dry-type Transformers, 600 Volts and below: Perform all tests, including all optional tests, listed in section 7.2.1.1 of NETA ATS.

C. Dry-type Transformers, above 600 Volts: Perform all tests, including all optional tests, listed in section 7.2.1.2 of NETA ATS.

D. Oil-filled Transformers: Perform all tests, including all optional tests, listed in section 7.2.2 of NETA ATS.

E. Switches:

1. Low Voltage Air Switches, 60 ampere and larger: Perform all tests, including all optional tests, listed in section 7.5.1.1 of NETA ATS.

2. Medium Voltage Air Switches: Perform all tests, including all optional tests, listed in section 7.5.1.2 of NETA ATS.

F. Circuit Breakers

1. Low Voltage, Insulated Case/Molded Case Breakers, 100 amp trip and larger: Perform all tests, including all optional tests, listed in section 7.6.1.1 of NETA ATS.

2. Low Voltage, Power Operated Breakers: Perform all tests, including all optional tests, listed in section 7.6.1.2 of NETA ATS.

3. Medium Voltage, Air Breakers: Perform all tests, including all optional tests, listed in section 7.6.1.3 of NETA ATS.

4. Medium Voltage, Vacuum Breakers: Perform all tests, including all optional tests, listed in section 7.6.3 of NETA ATS.

5. Medium Voltage, SF_6 Insulated Breakers: Perform all tests, including all optional tests, listed in section 7.6.4 of NETA ATS.

G. Protective Relays: Perform all tests, including all optional tests, listed in section 7.9 of NETA ATS.

H. Instrument Transformers: Perform all tests, including all optional tests, listed in section 7.10 of NETA ATS.

I. Metering: Perform all tests, including all optional tests, listed in section 7.11 of NETA ATS.

J. Motor Control Equipment, Low Voltage: Perform all tests, including all optional tests, listed in section 7.16.1.1 and 7.16.2.1 of NETA ATS

K. Emergency Power Generators: Perform all tests, including all optional tests, listed in section 7.22.1.1 of NETA ATS. Remainder of tests shall be performed by the equipment Manufacturer's Representative.

L. Automatic Transfer Systems: Perform all tests, including all optional tests, listed in section 7.22.3.1 and 7.22.3.2-1,2,3 of NETA ATS. Remainder of tests shall be performed by the equipment Manufacturer's Representative.

M. System Function Tests: Perform all tests, including all optional tests, listed in section 8 of NETA ATS.

N. Cables:

1. Low Voltage Feeders #2 and Larger, 600 volts and Below: Perform all tests, including all optional tests, listed in section 7.3.2 of NETA ATS.

2. Medium/High Voltage Cables: Perform all tests, including all optional tests, listed in section 7.3.3 of NETA ATS.

O. Grounding Systems: Perform all tests, including all optional tests, listed in section 7.13 of NETA ATS.

P. Ground Fault Protection Systems: Perform all tests, including all optional tests, listed in section 7.14 of NETA ATS.

Q. Motors 10 HP and Larger: Perform all tests, including all optional tests, listed in section 7.15.1.1 of NETA ATS.

PART 3 - DOCUMENTATION

3.1 REPORT

A. Three bound copies of the certified test reports shall be submitted to the Architect at the completion of the project.

B. The final report shall be fully indexed and signed. It shall include the following information:

1. Summary of the project

2. Description of equipment tested

3. Visual inspection report

4. Description of tests

5. Test results

6. Conclusions and recommendations

7. Appendix including appropriate test forms

8. Identification of test equipment used

END OF SECTION 26 00 52

SECTION 26 00 53-GENERAL WIRING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Provide materials, equipment, labor, and supervision necessary to install feeder, branch, control, and system circuits as required by the Drawings and this Section, to include:

1. Conductors
2. Conduit Fittings and Boxes
3. Overcurrent Protection
4. Panelboards
5. Conduit Hangers and Supports
6. Wiring Devices
7. Motor and Equipment Connections

1.3 STANDARDS AND CODES

A. Methods of fabrication and installation shall comply with the provisions of applicable articles in the NEC.

B. Materials shall be UL and NEC approved for the application intended.

PART 2 - PRODUCTS

2.1 RELATED EQUIPMENT AND MATERIAL

A. The equipment and material related to feeder and branch circuit systems as called for on the Drawings and specified in the electrical specifications.

B. The materials used in the installation of general wiring shall be products of manufacturers regularly engaged in the manufacturing of the specified material. Where a manufacturer is named for a particular material, the material of other manufacturers will be accepted provided the material meets requirements of the Specification.

2.2 APPROVED WIRING SYSTEMS

A. All raceways, conductors, and wiring systems furnished and installed under this project shall be restricted to that specifically described on the electrical construction drawings and/or in the electrical specifications.

B. Unless specifically noted otherwise on the Electrical Bid Documents, the Electrical Contractor shall not install Type AC armored cable, Type FC flat cable, Type FCC flat conductor cable, Types NM / NMC / NMS nonmetallic sheathed cable, Types SE / USE service cable or Type UF underground feed cable. Refer to Specification Section 26 01 20 for the limited use of MC Cable.

PART 3 - INSTALLATION

3.1 GENERAL

A. All wiring shall be furnished and installed complete from point of service connection to all receptacles, lighting fixtures, clocks, fans, power outlets and outlets for future extensions, etc., as indicated on the drawings. Ample slack wire shall be provided for motor loops, service connections, etc. Unless otherwise specified, all branch circuit conductors shall be # 12 AWG or larger. In outlet boxes for future installation of devices, ends of wires shall be taped and tagged for identification at both ends and outlets supplied with blank covers.

B. All conductors not larger than #10 located in branch circuit panelboards, signal cabinets, signal control boards, switchboards and motor control centers shall be neatly and securely bundled. All conductors larger than #10 located in switchboards, motor control centers and pull boxes shall be neatly and securely cabled in individual circuits. Bundling and cabling shall be done with either (1) marlin twine or 3 ply lacing or (2) nylon straps made of self-extinguishing nylon having temperature range of 65°F to 350°F. Each strap shall be constructed with a locking hub or head on one end and a taper on the other. Arcproofing, where required on feeders shall be applied after cabling.

C. Raceways subjected to different temperatures and where condensation may be a problem shall be filled with an approved material to prevent circulation of warm air to a colder section of the raceway. This shall include, but not be limited to, raceways passing from interior to exterior of buildings and raceways entering switch and control enclosures located outdoors.

D. Branch circuit wiring within fixture wireways of multiple unit sections or surface, recessed or pendant type fluorescent lighting fixtures shall be minimum #12 AWG stranded XHHW or THHN.

3.2 FEEDER CIRCUITS

A. A riser diagram and/or a general layout of feeder circuits are indicated on the Drawings. Contractor shall install the feeders generally as indicated, but shall determine the exact location and routing of feeders to best fit the field conditions.

B. In general, conductor sizes for feeder circuits are noted on the Drawings. Where conductor sizes for feeder circuits are not shown, the Contractor shall immediately notify the Engineer, who in-turn, will provide the missing information and further directives.

C. Feeder conductors shall be routed continuous from origin to destination, without splicing, unless specifically noted otherwise on plans.

D. Refer to Section 260120 for feeder conductor insulation, color coding, connectors, and support requirements.

3.3 BRANCH AND SYSTEM CIRCUITS

A. A general layout of branch circuit wiring is indicated on the Drawings. Generally, receptacles and appliances shall be on separate circuits from lighting.

B. Branch panel circuits are numbered to match NEMA pole numbering system; poles 1 and 2 - Phase A, poles 3 and 4 - Phase B, poles 5 and 6 - Phase C, etc.

C. Where homerun circuit numbers are shown on drawings, such numbers shall be followed in connecting circuits to panelboards. Each branch circuit homerun containing two or more circuits with a common neutral shall be connected to the circuit breakers or switches in such a manner that no two of the circuits will be fed from the same phase.

1. In general, 120V and 277V single phase circuits shall be provided with dedicated neutrals and connected to single pole breakers.

2. Where multi-wire circuits are installed for modular type furniture, multi-circuit plug mold and similar equipment with a common neutral, phase conductors shall be connected to a multi-pole breaker.

D. Each feeder and branch circuit associated with a two-pole or three-pole protective device shall be provided with a separate green insulated equipment grounding conductor. The required equipment grounding conductor shall be sized as shown on the drawings and shall not be smaller than shown in NEC Table 250.122 and shall be installed in a common conduit with the related phase and/or neutral conductors. In the case of parallel feeders, each raceway shall have a full size green insulated equipment ground conductor.

E. Where panelboard cabinets are recessed, conduits with sufficient capacity to carry the required number and size of future conductors for all spare branch circuit protective devices and spaces in the panelboard shall be stubbed out above accessible ceilings. In no case shall there be less than one 1" and three 3/4" conduits stubbed out.

1. Wireways shall not be installed above branch circuit panelboards. (Raceways shall terminate directly into panelboard tub).

F. Branch circuit conductor sizes shall minimally be #12 AWG. Where the length of a homerun, from panel to first outlet, exceeds 75 feet for a 120 volt circuit or 175 feet for a 277 volt circuit, the minimum conductor size shall be #10 AWG.

G. In general, conductor sizes for larger branch circuits, such as motor and equipment branch circuits, are noted on Drawings. Where conductor sizes for such circuits are not noted, Contractor shall provide branch circuit conductors sized as follows:

1. Conductors for individual motor branch circuits shall have ampere capacity of not less than 125% of the running current of the motors (Article 430.22, NEC).

2. Conductors for multiple motor branch circuits shall have ampere capacity of not less than 125% of the running current of the largest motor plus 100% of the running current for each additional motor connected to the circuit (Article 430.24, NEC).

3. Conductors for individual or multiple equipment branch circuits shall have an ampere capacity of not less than 125% of the total connected ampere load served by the branch circuit.

H. Where specific conductor sizes required by the Drawings are larger than the NEC requires, the larger sizes shall be installed.

I. Cables shall not be bent, either permanently or temporarily during installation, to radii less than 10 times the outer diameters, except where shorter radii are approved for conditions making the specified radius impractical.

J. No. 14 AWG wire shall be permitted only for systems control and alarm circuits.

K. All wiring for the individual specified systems (fire alarm, telephone/data, intercom, paging, etc.) shall be as scheduled on the drawings and/or as described within the appropriate spec Sections.

L. Refer to Section 260120 for conductor insulation, color coding, connectors, and support requirements.

END OF SECTION 26 00 53

SECTION 26 00 54-CUTTING AND PATCHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Furnish materials, tools, labor, and supervision necessary to cut and patch existing construction as required.

1.3 DESCRIPTION

A. This Section describes the cutting and patching of existing construction required by the installation of new electrical work and for the removal of existing electrical devices and wiring.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide proper materials to match existing construction.

PART 3 - EXECUTION

3.1 GENERAL

A. This Contractor shall provide all holes and channels in existing construction required for concealed installation of electrical wiring and equipment.

B. Holes and channels shall be cut as small as practical and in a manner satisfactory to the Architect.

C. This Contractor shall patch and "finish sand" all holes and channels cut for the installation of electrical wiring and electrical equipment and shall patch all damage caused by the installation and/or removal of electrical wiring and equipment.

D. Finishing (paint, wall covering, etc.) shall not be included under this Section.

E. Refer to Section 260056 for firestopping requirements.

END OF SECTION 26 00 54

SECTION 26 00 55-TEMPORARY POWER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Provide materials, equipment, labor, and supervision necessary to provide temporary lighting and temporary power, whether or not specifically called for on the plans, as required to facilitate completion of the project by all Trades. This section to include but not be limited to the following:

1. Conductors
2. Overcurrent Protection
3. Hangers and Supports
4. Wiring Devices
5. Safety Basketed Fixtures

1.3 STANDARDS AND CODES

A. Except where otherwise required by this Section, the following standards and codes shall govern:

1. Temporary Wiring: NEC Article 590

PART 2 - PRODUCTS

2.1 RELATED EQUIPMENT AND MATERIALS

A. The equipment and materials to provide temporary 208/120V 3-phase 4-wire feeders and branch circuit panelboards.

B. The equipment and materials related to temporary lighting.

C. The equipment and materials related to temporary power and receptacles.

PART 3 - EXECUTION

A. Furnish, install, and remove temporary lighting and power services required by all Trades for the completion of the project.

B. Provide load centers and GFCI protected receptacles as required by all Trades in full compliance with all OSHA regulations and all applicable codes.

C. Provide temporary safety basketed lighting throughout all construction areas. Provide 20A1P toggle type switches for group on/off control of all temporary lighting.

END OF SECTION 26 00 55

SECTION 26 00 56-FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Furnish materials, tools, labor, and supervision necessary to furnish and install fire stopping materials.

1.3 DESCRIPTION

A. Fire and smoke barriers shall be maintained at all locations where this Section contractor's work requires penetration.

B. Refer to Specification Section 260111 for installation of boxes in fire-rated walls.

C. The final installation shall meet requirements of the NEC, specifically paragraph 300.21, and other applicable building codes and regulations.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All products used under this Section shall be UL listed for the purpose.

B. Penetrations for conduits, cable, cable trays, bus ducts and sleeves shall be sealed with the appropriate intumescent caulk, putty, strip, block, sponge, or sheet type fire barrier product; Hilti "FS-One", Nelson "Flameseal", Specified Technologies Inc. "Spec Seal", International Protective Coatings "Flamesafe", CSD Sealing Systems, or approved equal as manufactured by 3M.

C. Firestopping materials shall be installed in accordance with all U.L. System requirements for the type of penetration and firestopping system used. The following U.L. System descriptions are those of Hilti Inc. firestopping systems.

PENETRATION	F RATING	U.L. SYSTEM
Metal pipe though gypsum board	1 or 2 hours	Hilti # W-L-1054 or approved equal
Metal pipe through masonry/concrete floor or wall	3 hours	Hilti # C-AJ-1155, #C-AJ-1226 or approved equal
Metal pipe through poured concrete floor slabs	3 hours	Hilti # F-A-1017 or approved equal
Metal pipe through wood floor/ceiling assembly	1 or 2 hours	Hilti # F-C-1059
Plastic pipe through masonry/concrete floor or wall	3 hours	Hilti # C-AJ-2109 or approved equal
Plastic pipe though gypsum wall assembly	1 or 2 hours	Hilti # W-L-2251
Plastic pipe though wood floor/ceiling assembly	1 or 2 hours	Hilti # F-C-2127
Cable though gypsum board	1 or 2 hours	Hilti # W-L-3065 or approved equal
Cable through masonry/concrete floor or wall	3 hours	Hilti # C-AJ-3095 or approved equal

PENETRATION	F RATING	U.L. SYSTEM
Cable though poured concrete floor slabs	3 hours	Hilti # F-A-3007 or approved equal
Cable/cable bundle through wood floor/ceiling assembly	1 or 2 hours	Hilti # F-C-3012
Cable tray though gypsum board	1 or 2 hours	Hilti # W-L-4011, # W-L-4019 or approved equal
Cable tray though masonry/concrete floor or wall	3 hours	Hilti # C-AJ-4035 or approved equal
Cable tray though gypsum wall assembly	1 or 2 hours	Hilti # W-L-4011
Multiple cable trays though masonry/concrete floor or wall	3 hours	Hilti # C-AJ-4017 or approved equal

PART 3 - EXECUTION

A. This Section Contractor shall install the firestopping materials as described per the manufacturer's instructions.

B. The Contractor shall show proof of compliance by providing the appropriate UL firestopping system number to the inspection authority having jurisdiction.

END OF SECTION 26 00 56

SECTION 26 00 60-EXCAVATING, TRENCHING, BACKFILLING AND RESTORATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Furnish materials, tools, labor, and supervision necessary to provide all excavating, trenching and backfilling required for the proper installation of electrical equipment and wiring.

B. Exact routing of trenching shall be determined by the Electrical Contractor and approved, in advance, by the Construction Manager and the Architect.

PART 2 - EXECUTION

2.1 EXISTING UNDERGROUND FACILITIES

A. Drawings indicate the approximate desired position of equipment and routing of ducts, pipe and conduits. If field conditions are encountered which make arrangements indicated impossible or impractical, submit request for deviation in writing to the engineer, with drawings where required to clarify the request. Do not proceed until the request has been accepted in writing.

B. Investigating, locating, marking and protecting existing underground facilities, public and private, shall be the responsibility of the Electrical Contractor.

C. The Electrical Contractor shall notify the Ohio Utilities Protection Service (OUPS) at 800-362-2764, and owners of utility facilities who are not members of OUPS, at least 48 hours prior to construction.

D. Any damage to underground facilities caused by the Electrical Contractor shall be repaired at no cost to the Owner.

E. Clearances of underground facilities shall be as follows:

1. Maintain minimum clearances of 12" vertical and 36" horizontal between proposed underground facilities and new and/or existing water lines.

2. Maintain minimum clearances of 18" vertical and 18" horizontal between proposed underground facilities and new and/or existing sanitary sewer lines.

3. Maintain minimum clearances of 12" vertical and 12" horizontal between proposed and existing underground facilities not listed above.

2.2 OPEN TRENCHING

A. The Electrical Contractor shall perform all excavating and trenching required for light pole bases, underground wiring, conduit, and duct banks.

1. Trenches shall be opened in straight lines and bottomed out at least 4" below conduits or ducts. Minimum depth as indicated shall be maintained between top of largest conduit or duct and finish grade.

2. Heavy steel plating shall be installed across all trenches where they traverse roadways, drives, and lot aisles to maintain existing traffic patterns throughout the construction period.

3. Care shall be taken in excavating that walls and footings and adjacent load bearing soils are not disturbed in any way. Where a line must pass under a footing, the crossing shall be made by the smallest possible trench to accommodate the duct or conduit.
4. Excavations shall be kept free from water by pumping if necessary. No greater length of trench shall be left open, in advance of conduit laying or duct installation, than that which is authorized or directed by the Construction Manager and/or the Architect.
5. Existing excavated concrete and asphalt shall be removed from the job site by the contractor.
6. Sub-base material, where suitable, shall be permitted to be used for backfilling. Unsuitable or surplus material shall be removed from the jobsite by the contractor.
7. Contractor shall cut any interfering trees, remove all stumps, rocks, etc. in the line of the excavation. Approval of the Architect must be obtained before any tree is removed.
8. Any shrubbery in line of excavation shall be removed with a ball of dirt and replaced at completion of excavation.
9. Roots shall be removed to a level of eighteen (18) inches below finished grades and deeper as required for duct runs, manholes, and light pole bases. No roots shall be allowed to remain under the work.

2.3 BACKFILLING AND RESTORATION

A. The Electrical Contractor shall perform all backfilling associated with the above described excavation work.

1. Backfill all trenches and excavations using suitable excavated materials as defined in ODOT 203 unless specifically noted otherwise on the Drawings.
2. Backfilling shall commence immediately after work has been inspected and shall progress as rapidly as the testing and acceptance of the finished sections of the work will permit.
3. Backfill about the structures shall be placed, when practical, as the work of construction progresses. Backfilling on or against concrete work shall commence only when directed.
4. Prior to backfilling the trench, conduits shall either be backfilled and compacted, or encased using one of the following methods, as required per the Drawings.
    a. Place fine aggregate consisting of natural sand or #8 granular material (3/8" diameter or less), as defined in ODOT 703, around raceways and compact material firmly around conduits to a depth of not less than four (4) inches over the top of the duct.
    b. In lieu of fine aggregate, the contractor may provide nonmetallic ties to prevent floating of conduits and encasement using low strength mortar backfill, as defined in ODOT 613, consisting of a flowable concrete mix. The concrete mix shall have a compressive strength between 50 and 100 psi at 28 days, which will allow future excavation.
    c. Where duct banks are indicated to be concrete encased, provide nonmetallic ties to prevent floating of conduits, use care in placing concrete to not damage or dislocate raceways, and liberally and continuously hand spade to insure there are not voids between and under conduits. Concrete shall be Class C, as defined in ODOT 499, with an average compressive strength of 4,000 psi at 28 days. Mechanical vibrators are not acceptable.
5. Trench backfilling and backfill around structures shall be compacted thoroughly in layers and shall be brought up to within six (6) inches of finished grades.

a. Backfill under roadways, drives, and parking areas shall be bank run gravel or approved granular material (ie, sand) and shall be installed in 6" layers, and tamped after each layer.

b. Backfill under building walls, and/or footers shall be concrete of the same strength as walls of footers.

c. Backfill in grassy areas shall be clean and free from vegetative matter, sticks, rocks and refuse.

B. All restoration work shall be performed by the Electrical Contractor in full compliance with all City regulations (where applicable), and Architect's directives.

1. Concrete areas shall be replaced to match.

2. Concrete walks shall be removed in full sections and replaced to match.

a. Sidewalks shall be 5" thick with 6" by 6" by 10/10 gauge welded wire reinforcement, cross slope, and textured finish.

b. Control joints shall be 8'-0" on center and expansion joints shall be as recommended per American Concrete Institute Standards.

3. Asphalt areas shall be replaced with 5" minimum ODOT 441 asphalt concrete surface.

a. Construction shall be 2" minimum Type 1 asphalt concrete wearing surface with 3" minimum Type 2 asphalt concrete intermediate surface and 6" minimum ODOT 301 crushed aggregate base.

b. Finished asphalt surface to be graded such as to avoid "ponding" of surface rain water.

4. Grassy areas shall be finished with 6" best grade topsoil that is free of all rocks and debris, compacted in layers and carried to a crown of approximately 6" above finished grade. Rake to remove all stones, heavily seed (fairlawn mix), and install 3" thick cover of straw and bio-degradable green netting that is anchored on all sides on 36" centers.

C. Shrubbery removed during excavation shall be replanted using backfill mix as defined in ODOT 661. Where shrubbery is indicated to be maintained, but does not survive construction or fails to establish after replanting, it shall be replaced.

END OF SECTION 26 00 60

SECTION 26 00 74-ELECTRICAL DEMOLITION AND SALVAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. In areas that are to be remodeled, provide labor, materials, equipment and supervision necessary to schedule and complete all work associated with the demolition and salvage of electrical equipment and wiring.

B. The Electrical Contractor shall provide protection for all adjacent areas before, during and following demolition operations.

C. Where remodeling of existing work is required, these specifications make no attempt to define exact extent of work involved, except to establish minimum standards for workmanship and materials. In general, make extensions to existing work with materials matching similar work remaining.

PART 2 - EXECUTION

2.1 DEMOLITION WORK - SERVICES

A. Active Services: When encountered, support active electrical services as necessary. If active services require relocation (other than those indicated on the drawings), obtain written instructions before proceeding. Do not disturb active services scheduled to remain.

B. Inactive Services: When encountered, remove conduit and wire full length. Notify servicing utility when encountered outside of structure.

C. Interruption of Service: When work progress makes temporary shutdown unavoidable, shutdown shall be at night or at such time as approved by Owner so as to cause minimum disruption to established operating routine. Arrange to work continuously, including overtime as necessary to re-establish service within shortest possible down time. In those instances where the length of time required for the service interruption is not acceptable to the Owner, furnish and install temporary wiring as required to reduce the length of time of service interruption to an acceptable level.

D. In areas where new construction ties into existing work or in remodeled areas, dismantle the existing electrical facilities as necessary. Relocate any existing services interfering with construction.

2.2 DEMOLITION WORK - GENERAL

A. Remove all existing electrical devices and wiring in remodeled areas that interfere with new construction and are not necessary to maintain service to equipment and devices that are to remain.

B. Relocate, and/or extend as required, wiring that interferes with new construction and is essential to maintain service to equipment and devices that are to remain.

C. Remove and/or relocate those devices specifically indicated on the drawings and as required to complete demolition work.

D. In those cases where devices are removed, the associated wiring that will no longer be active shall be removed.

E. All wiring and feeders to be removed shall be removed full length back to the source. Identify all abandoned feeder breakers as spare.

F. All holes or damage caused by the removal of existing work shall be properly patched. Holes shall be neatly patched with suitable materials to match existing surfaces. Conduits that penetrate the ground floor slab shall be cut flush with slab, filed to remove burrs, and grouted to match floor.

G. Furnish and install blank coverplates over all abandoned outlet boxes.

2.3 SAFE DISPOSAL OF BALLASTS AND LAMPS

A. Electrical Contractor shall safely dispose of all fluorescent and HID ballasts and lamps in full compliance with all Federal and State of Ohio EPA regulations.

B. Electrical Contractor shall; under the base bid proposal; package, dispose, and/or recycle all lamps and ballasts removed under the demolition portion of this contract.

1. Disposal shall be completed at an EPA approved hazardous waste facility.

2. Recycling shall be completed by an EPA approved recycle facility.

C. Electrical Contractor shall provide both Owner and Architect with copies of all lamp and ballast disposal/recycle documentation in accordance with US EPA and State EPA regulations.

2.4 SALVAGE

A. All electrical material and devices that are removed shall be stored on the site for salvage by the Owner. All items not selected for salvage shall become the property of the Electrical Contractor and shall be removed from the site by the Electrical Contractor.

PART 3 - EXECUTION - (NOT USED)

END OF SECTION 26 00 74

SECTION 26 01 11-CONDUIT SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Furnish materials, tools, labor, and supervision necessary to fabricate and install complete conduit systems.

B. Conduit systems shall be provided for all wiring, except where the Drawings or other specification sections indicate that wiring is permitted to be installed without conduit.

1.3 STANDARDS AND CODES

A. Methods of fabrication and installation shall comply with the provisions of applicable Section NEC, Article 300.

B. Materials shall be UL and NEC approved for the application intended.

1.4 DESCRIPTION

A. This Section describes the basic materials and methods of installation for circular cross section conduit systems. Other types of conduit or raceways when required shall be as specified in other Sections, or as called for on the Drawings.

1.5 QUALIFICATIONS

A. The materials used in the fabrication of the conduit system shall be products of a manufacturer regularly engaged in the manufacturing of the specified material. Where a manufacturer is named for a particular material, the material of other manufacturers shall be acceptable provided the material meets requirements of the specification.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Coated Rigid Conduit: Full weight, threaded, rigid steel, 40 mil PVC coated on outside, 2 mil urethane coated on inside conduit. Approved sources for this raceway are Robroy "Plastibond-Red" (Westwood Electrical Sales, 440-835-9960), Ocal, Inc "Ocal-Blue" (Greisser Sales, 216-771-6120), or Calpipe Industries "Calbond" (Fields Electrical Sales, 513-228-1010). All associated raceway fittings, sweeps, etc., shall be coated. Field cut raceways shall be touched up with matching finish. Use for all conduit, regardless of size, where installed in earth fill, or where specifically required by the drawings.

B. Rigid Conduit - Steel: Full weight, threaded, rigid steel conduit, galvanized inside and out by hot dip or electro galvanizing process with electrostatically applied baked coating. Use for all conduit, regardless of size, where installed in poured concrete walls, columns, floors or other concrete slabs or where specifically required by the drawings.

C. Rigid Conduit - Aluminum: Full weight, threaded, rigid aluminum conduit may be used for all conduit, regardless of size, where installed exposed outdoors on roofs or in damp/wet locations or where specifically required by the drawings. Expansion fittings and supports shall be utilized to absorb and prevent deflections due to thermal expansion.

D. Intermediate Metal Conduit (IMC): May be used as approved by the NEC for 2" and larger where rigid conduit is specified. IMC shall not be used for conduit buried in earth fill.

E. Electrical Metallic Tubing: Thinwall, electrically welded cold rolled steel conduit, galvanized inside and out by electro galvanized process. Baked clear elastic enamel coating. Use indoors for conduit sizes through 4", where installed concealed in walls and above suspended ceilings and where exposed.

F. Flexible Metal Conduit: Formed of one continuous length of spirally wound electro galvanized steel strip. Use for final connections to equipment such as unit heaters, fans, air handling units, pumps, dry type transformers, and for wiring within casework and millwork. Aluminum flexible conduit may be used for connections from junction boxes to lighting fixtures.

G. Liquid-tight Flexible Metal Conduit: Formed of one continuous length of spirally wound steel strip, with water and oil tight neoprene jacket. Use for final connections to equipment listed in paragraph F above when located in wet or damp areas. Liquid-tight conduit shall not be used in environmental air plenums, except for branch circuits installed under a raised floor per the alternative wiring methods of NEC article 645.

H. PVC Conduit: Schedule 40 heavy wall rigid, rated for 90°C cable, composed of polyvinyl chloride and shall conform to NEMA Standards. Conduit, fittings, and pipe-joining materials shall be produced by the same manufacturer. At Contractor's option and where permitted by NEC and local jurisdiction, PVC conduit may be used where buried outside building, or encased in concrete, or in/below floor slabs. PVC conduit shall not be used on environmental air plenums. Electrical Contractor shall be responsible for upsizing raceway if necessary as required by NEC.

I. Fiberglass Conduit: Reinforced Thermosetting Resin Conduit (RTRC) manufactured using epoxy based resin, with no fillers, using a single circuit filament winding process on a non-tapered mandrel. The fiberglass shall be halogen free with additives for lowering smoke density and providing ultra violet protection. The internal conduit and elbow walls shall be smooth with all fibers embedded in the epoxy. Use where specifically required by the drawings.

J. Fibrous nonmetallic tubing (loom) and non-metallic sheathed cable shall not be used.

K. Refer to Specification Section 26 01 20 for the limited use of MC Cable.

2.2 CONDUIT FITTINGS

A. Rigid Conduit Fittings: Threaded, galvanized malleable iron or heavy steel, water and concrete tight.

B. Metallic Tubing Fittings: Set screw type galvanized steel, concrete tight. Die cast type indentor type fittings will not be allowed.

C. Flexible Metal Conduit Fittings: Squeeze or screw type galvanized malleable iron or steel with nylon insulated throats, or steel with set screws.

D. Liquid-tight Flexible Metal Conduit: Galvanized malleable iron or steel, with watertight gaskets, "O" ring and retainer, and nylon insulated throats.

E. Condulet Fittings: Exposed conduit fittings shall be condulet type for sharp turns, tees, etc. Condulet covers shall be gasketed where exposed to moisture.

F. PVC Conduit: Elbows associated with feeders shall be long-sweep PVC Schedule 80, galvanized rigid, or fiberglass.

G. Fiberglass Conduit: Elbows associated with feeders shall be long-sweep with deep socket PVC couplings to facilitate transitions to other raceway systems. Straight couplings shall be made using integral conduit bell ends.

H. Threaded conduit terminations for weatherproof applications shall be made by use of Myers Hubs.

2.3 OUTLET BOXES

A. Material, size and installation for outlet boxes shall comply with NEC Article 314.

B. Boxes shall be Raco, Steel City, Appleton or equivalent, catalog numbers listed below are based on Raco, unless otherwise indicated. In general the type of boxes shall be as follows:

1. In stud walls: For single outlet use 4" square by 2-1/8" deep box No. 232 or 233. For ganged outlets use 4-1/2" high by 1-13/16" deep multiple gang boxes No. 951 through No. 958. Boxes to be provided with raised adapters of depth as required for thickness of wall materials.

2. In masonry and poured concrete walls: For single outlets requiring two conduit connections in top and/or bottom of box use 4" square by 2-1/8" deep box No. 232 or 233 with raised square cut adapter. For ganged outlets use 3-3/4" high by 2-1/2" deep multiple gang masonry boxes No. 691 through No. 694 and No. 960 through No. 964.

3. Surface mounted wall outlets: For single outlet use 2-1/8" deep handy box No. 674, for two outlets use 4" square by 2-1/8" deep box No. 232 or 233. For more than two ganged outlets use 3-3/4" by 2-1/2" deep multiple gang masonry boxes No. 692 through No. 694 and No. 960 through No. 964. Boxes to be provided with 1/2" raised cover as required for device.

4. In suspended ceilings: Use 3-1/2" deep octagon box No. 280 or No. 281 with fixture studs and steel mounting bars.

5. In poured concrete ceiling slabs: Use octagon concrete rings with back plates.

6. Where outlet boxes are free standing on conduit stubs in kitchens, laundries, shops and other areas indicated, use Crouse-Hinds Type FS or FD malleable iron cadmium finish boxes with appropriate gasketed cover plate to suit device.

7. Outlets installed outdoors or in wet locations: Use Crouse-Hinds Type FS or FD box with NEMA 3R coverplates listed for "raintight while in use" for receptacles. Covers for switches shall be Crouse Hinds No. DS185. Diecast "bell" type boxes are not acceptable.

8. Floor outlets in above grade concrete slabs: Use concrete tight stamped steel galvanized box with fully adjustable top, Hubbell No. B-2527 for greater than 3" fill, No. B-2529 for 2" to 3" fill. Floor outlets in concrete slabs on grade: Use watertight cast iron box with fully adjustable top, Hubbell No. B-2536 for greater than 3" fill, No. B-2537 for 2" to 3" fill. Furnish for each outlet a No. S-2525 cover. Service fittings shall be as described on the Drawings. Furnish for each outlet in carpeted floor a No. S-3082 carpet flange.

2.4 PULL AND JUNCTION BOXES

A. Construction, size and installation of pull and junction boxes shall comply with NEC, Article 314.

B. Pull and junction boxes shall be fabricated of heavy gauge galvanized steel with screw covers, brass screws and hardware with enamel finish.

C. Pull and junction boxes for installation in poured concrete floors shall be flush type, cast iron, with watertight gasketed covers. Boxes for installation in floors with tile or carpet floor covering shall have recessed covers to accommodate the floor covering.

D. Pull and junction boxes for above grade outdoor installations shall be rain-tight.

E. Grade level junction boxes shall be manufactured by CDR Systems, Synertech, or Quazite with open flared bottom and cover. Logo on cover to read "ELECTRIC", etc. Enclosures and covers shall be concrete gray color and rated for no less than 5,000 pounds over a 10" x 10" area and be designed and tested to temperatures of -50 degrees F. Material compressive strength should be no less than 11,000 psi. Covers shall be secured with two pentahead stainless steel bolts. Bolts shall be retained in lid when unscrewed. Bolts shall be secured to replaceable threaded inserts with openings at base to allow debris to fall through and thereby avoiding clogged threaded inserts.

2.5 AUXILIARY GUTTERS

A. Construction, sizes and installation of auxiliary gutters shall comply with NEC, Article 366.

2.6 HANGERS AND SUPPORTS

A. Provide conduit hanger and support devices of approved type for required methods of support to include: structural steel members, suspension rods, conduit clamps, concrete inserts, expansion shields, beam clamps and welding pins. All devices shall have galvanized finish or other approved corrosion resistive finish. In general, hangers and supports shall be as follows:

1. Where a multiple run of conduit is routed on surface of structure, use conduit clamps mounted on Unistrut or equal channel so as to maintain clearance between conduit and structure.

2. Where single run of conduit is suspended from overhead; use split ring conduit clamp suspended by steel drop rod.

3. Where multiple parallel runs of conduit are suspended from overhead; use split ring conduit clamps uniformly spaced and supported on trapeze hangers fabricated of Unistrut Channels, suspended by not less than 1/2" continuously threaded steel drop rods.

4. Where conduit is buried in concrete floor slabs; anchor conduit to structural floor with conduit clamps, at 10'-0" (maximum) intervals.

5. Any form of strap iron or wire hangers will not be accepted.

6. Maximum hanger and support spacing shall be in accordance with NEC Sections 342.30 (IMC), 344.30 (GRC), and 358.30 (EMT). Regardless of listed spacing provide additional hangers or supports at not more than 2'-0" from each change of direction and at each side of any box or fitting.

B. Hangers and supports shall be anchored to structure as follows:

1. Hangers and supports anchored to poured concrete: Use malleable iron or steel concrete inserts attached to concrete forms.

2. Hangers or supports anchored to precast concrete: Use self-drilling expansion shields. Expansion shields may also be used where concrete inserts have been missed or additional support is required in poured concrete.

3. Hangers or supports anchored to structural steel: Use beam clamps and/or steel channels as required by structural system.

4. Hangers or supports anchored to metal deck: Use spring clips or approved welding pins. Maximum permissible load on each hanger shall not exceed 50 pounds.

5. The use of explosive force hammer actuated, booster assist or similar anchoring device will not be permitted without prior approval of the Architect.

PART 3 - EXECUTION

3.1 CONDUIT INSTALLATION

A. In general, horizontal runs of conduit shall be installed in ceiling plenum. Conduit for convenience outlets, wall mounted fixtures and other wall outlets shall be routed overhead and concealed in wall to the outlet. Conduit shall not be installed in concrete floor slabs except where conditions will not permit the conduit to be routed overhead.

B. Generally, conduit shall be concealed, except in crawl spaces, tunnels, shafts, mechanical equipment rooms, and at connections to surface panels and free-standing equipment, and as otherwise noted on Drawings. No surface raceways shall be used on the floor.

C. Exposed conduit shall be routed in lines parallel to building construction lines. Exposed conduit locations shall be approved by the Architect prior to installation.

D. No conduit shall be installed less than 6" from piping installed by other trades. Conduits shall be located to avoid ductwork, piping and other obstructions.

E. Certain conduits are permitted to be embedded in structural concrete work. Contractor shall cooperate with other Contractors of their respective trades to effect the following:

1. Reinforcing steel shall be securely anchored in place before installing conduit.
2. No steel reinforcing shall be displaced from plan dimensions without approval of Architect.
3. Conduit shall not be placed over top of reinforcing or under bottom of reinforcing, where crossing beams.
4. Conduit and fittings shall not displace concrete in columns in excess of 4% of total cross-section area of column without approval of Architect.
5. Conduit shall not be placed closer than 3 diameters on center.
6. Maximum size of embedded conduit or pipe shall not exceed 1/3 thickness of structural slab; 2/3 thickness of topping slab.

F. Minimum size conduit shall be 1/2" trade size. Where specific size is not called for on Drawings or in the specification, Contractor shall select size required from Chapter 9 of NEC. Where specific sizes required by Drawings or Specifications are larger than Code requires, the larger size shall be installed.

G. Install the conduit system mechanically and electrically continuous from outlet to outlet and to cabinets, junction or pull boxes. Conduit shall enter and be secured to cabinets and boxes in such a manner that all parts of the system will have electrical continuity. Feeder raceways shall terminate in cabinets and pull boxes with double locknuts and insulating bushings.

H. Flexible metallic conduit and liquid-tight metallic conduit used for final connections to equipment shall be between 2-foot and 6-foot in length. Longer runs shall be permitted where conduit is fished into existing walls or inaccessible ceilings, installed in casework, or installed for branch circuits under a raised floor per the alternative wiring methods of NEC article 645.

I. Metal conduit buried in earth fill shall be protected with an approved corrosion resistant material.

J. Conduits installed on exteriors of buildings or other structures shall be arranged to drain (not trap water), and shall be rain-tight in wet locations.

K. Where conduits are routed through areas of differing temperatures or air pressures (air handlers, exterior walls, etc.), the penetration around the conduit shall be adequately sealed. The interior of these conduits shall be sealed at the first box or fitting adjacent to the penetration to prevent air mitigation between the spaces. Conduit sealant shall be Polywater FST, or approved equal.

L. Conduits shall be capped during construction to prevent the entrance of foreign materials and moisture.

M. Where conduits cross building expansion joints, O-Z Gedney Company type "DX" conduit expansion fittings complete with bonding jumpers shall be used.

N. Contractor shall cut and patch existing construction for conduit installation as required.

3.2 OUTLET BOX INSTALLATION

A. Outlet boxes shall be installed for fixtures, switches, receptacles and other devices.

B. Approximate location of outlets are shown on the plans, but each outlet location shall be verified by the Contractor before installing the outlet box.

C. Openings for electrical boxes in fire-rated walls that do not exceed 16 square inches in area are permitted in fire-rated construction provided that the aggregate area of such openings does not exceed 100 square inches for any 100 square feet of wall area.

D. Where service utility boxes greater than 16 square inches exist in fire-rated wall construction, if the opening is not otherwise detailed to maintain the fire-rated integrity of the wall, provide firestopping wrap to the back side of each utility box.

E. Outlet boxes on opposite sides of fire-rated walls shall be separated by a horizontal distance of not less than 24 inches.

F. Outlet boxes installed flush in a common wall shall not be back-to-back or through-wall type, unless construction requires same. Where it is necessary to install boxes back-to-back, install sound absorption material between boxes and seal the conduit nipple between boxes with duct seal.

G. Boxes located on opposite sides of a common wall that are connected by 12" conduit length or less, shall have the conduit openings plugged with duct seal at both ends.

H. Outlet boxes shall be installed plumb and square with wall face and with front of box or cover located within 1/8" of face of finish wall. Boxes in masonry shall be set with bottom of the box tight to the masonry unit.

3.3 PULL AND JUNCTION BOX AND GUTTER INSTALLATION

A. Install pull boxes, junction boxes and auxiliary wiring gutters where indicated on Drawings and where required to facilitate installation of the wiring.

B. For concealed conduit, install boxes flush with ceiling or wall, with covers accessible and easily removable. Where flush boxes are installed in finished ceilings or walls, provide cover which shall exceed the box face dimensions by a sufficient amount to allow no gap between box and finished material.

C. Boxes shall not be exposed in finished, occupied rooms, without prior approval of Architect.

3.4 HANGER AND SUPPORT INSTALLATION

A. Hangers and supports shall be installed for all conduit and boxes.

B. Where encountered, steel fireproofing shall be repaired by the electrical contractor where supports are installed on existing steel structures.

C. Conduit and boxes shall not be attached to or supported from mechanical pipes, plumbing pipes or sheet metal ducts.

D. Conduits routed in lay-in grid ceiling plenum shall not be supported from the ceiling hanger iron or ceiling tees.

END OF SECTION 26 01 11

SECTION 26 01 14-CABLE TRAY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Provide material, equipment, labor, and supervision as required for the complete installation of cable tray as required by the Drawings and this Specification.

1.3 STANDARDS AND CODES

A. The cable tray system installation furnished under this specification shall comply with the applicable provisions of the following standards and codes:

1. "Listed" & "Labeled" as defined by NFPA 70, National Electrical Code Article 100.
2. NFPA 70, National Electrical Code Article 392.
3. NEMA VE1, Metal Cable Tray Systems.
4. NEMA VE2, Cable Tray Installation Guidelines.
5. TIA 569-A, Commercial Building Standard for Telecom. Pathways & Spaces.
6. State and Local Codes.

1.4 QUALIFICATIONS

A. The basket and ladder tray shall be as manufactured by one of the following:

1. B-Line
2. Cablofil
3. Chalfant
4. MPHusky
5. Mono-Systems
6. Middle Atlantic
7. Chatsworth
8. HOMACO

B. Substitute cable tray manufacturers must be approved by the Engineer prior to submission of the electrical bids.

1.5 SUBMITTALS

A. Prior to purchase of any equipment, submit shop drawings to Engineer for approval. Submittals shall include:

1. Equipment brochure with specification sheets.
2. Dimensions of tray, fittings, and accessories.
3. Tray fill capacity and load charts.
4. Listing of all materials furnished with the system, including: clamps, brackets, hanger rods, splice plate connectors, expansion-joint assemblies, straight lengths, and fitting.

1.6 COORDINATION

A. Coordinate layout and installation of cable tray with other trades.

1. Cable tray location shall be as indicated on the Drawings, where required to suit field conditions, the Contractor may make minimal adjustment to the location and installation elevation.

2. Cable trays and accessories shall be protected from weather and construction traffic to prevent breakage, denting, and abrasion of finish. Damaged products shall not be installed.

PART 2 - PRODUCTS

2.1 BASKET CABLE TRAY

A. Basket tray shall be of the wire mesh type with 12" width and 4" depth.

B. Basket tray shall be constructed of continuous welded steel wire mesh with maximum open space of 2" by 4". Basket tray edges shall be rounded with smooth surfaces and electroplated zinc galvanized finish.

C. Fittings, inserts, covers, couplings, connectors and other accessories required to effect a complete rigid mechanical installation shall be of compatible material.

D. Basket tray shall be capable of minimally carrying a uniformly distributed load of 50 pounds per foot. Tray supports shall be spaced as required to achieve distributed load rating.

E. Basket tray shall be electrically continuous with bonding as required by the cable tray manufacturer.

2.2 LADDER CABLE TRAY

A. Ladder tray shall be of ventilated ladder type with 36" width and 9" rung spacing.

B. Ladder tray shall be constructed of 1.5" thick rectangular steel tubes connected with 1" wide by 1/2" thick rungs and painted finish.

C. Fittings, inserts, covers, couplings, connectors and other accessories required to effect a complete rigid mechanical installation shall be of compatible material.

D. Ladder tray shall be furnished with cable drop accessory, one per rack minimum.

E. Ladder tray shall be capable of minimally carrying a uniformly distributed load of 100 pounds per foot. Ladder tray supports shall be spaced as required to achieve distributed load rating.

F. Ladder tray shall be electrically continuous with bonding as required by the ladder tray manufacturer.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Vertical support hangers shall be factory fabricated, single channel, zinc plated steel.

B. Support hanger spacing shall not exceed 8'-0" centers. Provide all required steel rods, supports and accessories.

C. All tray installation supports shall be independently and rigidly secured to the building structure. Auxiliary supports required to span obstructions (ductwork, drains, etc.) shall be Unistrut channel or equal.

D. Burrs and sharp edges shall be removed to provide a smooth surface.

E. Basket tray wires shall be cut in accordance with manufacturers instructions.

1. Side-action bolt cutters with and offset head shall be utilized to ensure integrity of protective galvanic layer.

END OF SECTION 26 01 14

SECTION 26 01 20-Wire and Cable

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Furnish material, tools, labor, and supervision necessary to install wire and cable.

1.3 STANDARDS AND CODES

A. Methods of installation shall comply with the provisions of applicable sections of NEC, Article 300.

B. Materials shall be in accordance with NEC, Article 310 and shall be UL listed for application intended.

1.4 DESCRIPTION

A. This section describes the basic materials and methods of installation for general wiring systems of 600 volts and less. Wiring for a higher voltage rating, if required, shall be as specified in other sections or as called for on the drawings.

B. Minimum size conductors shall be No. 12 AWG for power and lighting and No. 14 AWG for signal and control.

C. Refer to Spec Section 260053 for specific instructions with respect to sizing and installation of feeder and branch circuit conductors.

1.5 QUALIFICATIONS

A. The material used for the wiring systems shall be the products of a manufacturer regularly engaged in the manufacturing of the specified material. Where a manufacturer is named for a particular material, the material of other manufacturers will be acceptable provided the material meets requirements of the Specifications.

PART 2 - PRODUCTS

2.1 WIRE AND CABLE

A. Wire and cable for power, lighting, control and signal circuits shall have copper conductors of not less than 98% conductivity and shall be insulated to 600V. Conductors shall be stranded except where specifically noted otherwise.

B. Wire and cable type for the various applications shall be as follows:

1. Type THWN or XHHW (75°C): Use for branch circuits, panel and equipment feeders in wet and dry locations.

2. Type THHN or XHHW (90°C): Use for branch circuits, panel and equipment feeders in dry locations only. Use where lighting branch circuit conductors are routed through fluorescent fixture channels.

3. Type "VFD Rated" cable: Feeders, size #8 AWG and larger, from variable frequency drives shall be multi-conductor shielded cables with the following performance requirements.

a. Phase conductors shall be tinned copper, extra flexible 34 AWG Class M stranding (size 10 AWG and smaller) or 30 AWG Class K stranding (size 8 AWG and larger), with XLPE insulation.

b. Ground conductors shall be tinned copper, 100% rated, and symmetrically spaced (three ground cables total).

c. Shielding shall consist of 100% aluminum foil shield with 85% tinned copper braided shield (size 2 AWG and smaller) or two (2) copper tape shields with 100% coverage (size 1 AWG and larger).

d. Overall cable jacket shall be type TPE, sunlight and oil resistant, and have a tray cable exposed rating, Type TC-ER.

4. Type UF: Use where permitted by other Sections or by the drawings for underground direct burial branch circuits.

5. Type AF or SF-2 silicone rubber with heat-resistant glass braid (rated minimum 150°C) shall be used for branch circuit conductors connecting to fixture conductors within the fixture housing or to a connection box attached to the fixture and subject to temperatures equal to the temperatures within the fixture housing.

6. Metal Clad Cable (NEC Type MC):

a. Metal Clad Cable (MC Cable) may only be used where permitted by the NEC, Local Codes and the following limitations.

1). For branch circuit wiring fished into existing walls or inaccessible ceilings and in casework. (MC Cable shall not be installed above ceilings in lengths greater than 8 feet.)

2). For lighting, receptacle and equipment branch circuit wiring with-in a room, where concealed in walls and above finished ceilings. All associated "home run" wiring shall be installed in conduit.

3). MC Cable shall not be installed exposed on walls.

4). MC Cable is not permitted for feeder circuits.

5). MC Cable is not permitted for emergency power circuits, except where fished into existing walls or inaccessible ceilings.

6). Ungrounded conductors shall be identified per NEC 210.5.C.

b. MC Cable shall be UL listed for its use. Where MC Cable is installed in Healthcare Facilities (as defined by the NEC), the cable assembly shall be listed for use in patient care areas (HCF).

c. Conductors in the MC Cable assembly shall comply with above.

2.2 CONDUCTOR COLOR CODING AND IDENTIFICATION

A. Wiring systems shall be color coded. Conductor insulation shall be factory colored in sizes up through No. 8 AWG. Conductors No. 6 AWG and larger shall have black insulation and shall be phase color coded with one half inch band of colored tape at all junctions and terminations. Colors shall be assigned to each conductor as described below and carried throughout all main and branch circuit distribution.

	208/120 Volt	480/277 Volt
Phase 'A'	Black	Brown
Phase 'B'	Red	Orange
Phase 'C'	Blue	Yellow
Neutral	White	Gray
Equipment Ground	Green	Green
Isolated Equipment Grounding	Green w/ Yellow Stripe	

B.

C. Contractor shall take extraordinary care to ensure that phase and bus orientation in each and every panel is identical.

D. Control wiring shall be color coded such that red is used exclusively for all 120 volt conductors and white for all neutral conductors. All control wiring to be identified at both ends with permanent wire markers.

2.3 CONNECTORS

A. Splices and junctions for conductors #8 AWG and smaller shall be 600V rated with "live spring" and insulated rigid nylon wing style body, 3M "Performance Plus", Ideal "Buchanan B-Cap", or equal.

B. In-line connectors for 600V copper conductors #6 AWG thru #3 AWG shall be ILSCO type "CT" circumferential compression sleeves or equal by 3M, Burndy, or Thomas & Betts.

C. In-line connectors for 600V copper conductors #2 AWG and larger shall be extra long barrel dual-crimp ILSCO type "CTL" compression sleeves or equal by 3M, Burndy, or Thomas & Betts.

D. Insulate in-line connectors with cold shrink silicone insulators 3M "8440" series.

E. Taps for copper conductor 600V or less, sizes No. #6 AWG and larger shall be ILSCO "AH" series or equal by 3M, Burndy, or Thomas & Betts.

F. Insulate taps to thickness of conductor insulation with half-lapped layers of 3M "Scotch" brand No. 33 vinyl electrical tape. Connectors having irregular surfaces; fill voids and smooth contours with 3M "Scotchfil" electrical putty prior to taping.

G. Where mechanical style connections are permitted, cable terminations to bus bars and switch pads shall be ILSCO "TA" two-hole mechanical or equal by 3M, Burndy, or Thomas & Betts.

H. Where compression style connections are required, cable terminations to bus bars and switch pads shall be ILSCO "CLWD" two-hole long-barrel dual-crimp compression type with sight hole or equal by 3M, Burndy, or Thomas & Betts.

1. Lugs installed in wet locations on poles or outdoors where exposed shall be furnished without sight hole, ILSCO "CLND" or equal by 3M, Burndy, or Thomas & Betts.

I. Mechanical and compression termination bolt/stud size and mounting hole spacing shall match factory bus hole size. Stacking lugs and spacers shall be provided as required for parallel cable runs.

J. Cable terminations at motors shall be bolted and removable with 1-hole copper compression lugs on the motor pigtail and feeder conductors, and motor terminal insulation kit 3M "5300" series, or equal. Motor terminal insulation kit shall include lug cover, mastic strip Scotch No. 2230, silicone grease, and Scotch No. 33 tape.

PART 3 - EXECUTION

3.1 PREPARATION

A. For new construction, wiring shall not be installed in the conduit system until the building is enclosed and masonry work is completed.

B. Conduit shall be swabbed free of moisture and debris prior to pulling in the conductors.

3.2 CONDUCTOR INSTALLATION

A. Feeder conductors shall be routed continuous from origin to destination, without splicing, unless specifically noted otherwise on the drawings.

B. Power feeder conductors shall be pulled with the use of an approved pulling compound or powder, and per the requirements of Section 260125.

C. Conductor splices shall be made only in readily accessible junction boxes.

D. Cable supports and boxes shall be installed in all vertical feeders required by Article 300.19 of the National Electrical Code. Cables shall be supported at the top of the vertical raceway plus an additional support for each interval of spacing as specified in table 300.19 (A) of the NEC. For cables without a metallic sheath, the cable support shall be of the split wedge type which clamps each individual conductor firmly and tightens due to weight of cables.

E. "VFD Rated" multi-conductor shielded cables shall be terminated according to the manufacturers recommendations. Braided shields shall be routed unbroken where service disconnects are located between the VFD and motor. Phase and ground conductors shall be pulled through braided shields at each end and terminated together with the ground conductors.

3.3 CONDUCTOR TERMINATIONS

A. Terminations materials shall be as required by the equipment manufacturer’s installation guidelines.

B. Bolt diameter shall be properly sized for the terminations, in the absence of manufacturer's installation requirements, the largest diameter shall be used.

C. Bolts shall be tightened to the torque values specific to the material, threads per inch, and nominal diameter. Bolted connections shall not be lubricated.

D. Unless stipulated otherwise, the minimum grade bolt material shall be SAE J429 Grade 5 medium carbon steel.

E. Belleville spring type washers shall be utilized for termination of conductors 350MCM and larger. Split ring lock washers shall be utilized on smaller conductor terminations.

F. Connections shall be initialed or otherwise labeled after final torqueing.

END OF SECTION 26 01 20

SECTION 26 01 25-PULLING CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Provide material, equipment, labor, and supervision as required for the complete installation of wire and cable in raceways.

1.3 CODES AND STANDARDS

A. Methods of installation shall comply with the provisions of applicable sections of NEC Article 300.

PART 2 - PRODUCTS

2.1 Products shall be used as described under Part 3.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Suitable installation equipment shall be provided to prevent conductor and raceway damage during the installation of feeders. Ropes used for pulling of feeders in metallic raceways shall be made of polyethylene or other suitable non-metallic material. Metallic ropes shall not be used.

B. Cable installation in PVC or similar non-metallic raceways or innerducts require the use of woven pull tapes. Tapes shall be Fibertek or equal.

C. A #14 galvanized steel fish wire or a plastic line having a tensile strength of not less than 200 pounds shall be installed in each conduit, except underground conduits, in which installation of conductors is not included in this section of the Specification. A #10 AWG bare, hard drawn copper shall be installed in each underground conduit or duct, in which installation of conductors is not included in this section of the Specification. Woven tape with embedded copper conductor may be used in lieu of #10 bare. Fibertek "Tracertape" or approved equal.

D. Fish wires and lines shall be free from splices and shall have ample exposed length at each end.

E. Wire pulling lubricants, if used, shall conform to UL requirements applicable to the several insulation and raceway materials.

F. Cables shall not be bent, either permanently or temporarily during installation, to radii less than 10 times the outer diameters, except where shorter radii are approved for conditions making the specified radius impractical.

G. Pulling lines shall be attached to conductor cables by means of either woven basket grips or pulling eyes attached directly to the conductors. Rope hitches shall not be used. All cables to be installed in a single conduit shall be pulled in together. Where polyethylene insulation is used and a pulling lubricant is required, the lubricant shall be certified by the manufacturer to be non-injurious to polyethylene insulation.

H. Refer to Section 260120 for cable supports and boxes required for installation of all vertical feeders.

END OF SECTION 26 01 25

SECTION 26 01 40-WIRING DEVICES AND PLATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Provide materials, equipment, labor, and supervision necessary to install wiring devices as required by the Drawings and this section.

1.3 STANDARDS AND CODES

A. Except where otherwise required by this section, the following Standards and Codes shall govern:

1. Receptacles; NEC Article 406
2. Wall Switches; NEC Article 404
3. UL Listed
4. NEMA Standards

1.4 QUALIFICATIONS

A. Products by Hubbell HBL series, Pass & Seymour - Industrial Spec Grade Series, Leviton - Lev-Spec Series and Eaton-Arrow Hart - Industrial Spec Grade Series are acceptable.

B. Pin and sleeve connectors by Menekes or Hubbell are acceptable.

1.5 SUBMITTALS

A. Prior to the purchase of wiring devices and plates, submit shop Drawings for approval per the requirements of Section 26 00 51.

PART 2 - PRODUCTS

2.1 GENERAL

A. All wiring devices shall minimally be "Industrial Specification Grade" except where higher grade is required by the Drawings.

B. Wiring devices shall be ivory in color, unless specifically noted otherwise in the symbol schedule on the Drawings.

2.2 SWITCHES

A. Wall switches shall be as described in the Symbol Schedule on the Drawings and be UL20 Listed.

B. Switches shall contain a 1-piece plated steel bridge.

C. Plug tail devices are listed underlined in table below for each device where available. Acceptable manufacturers and product lines are as follows:

Toggle Switches	Eaton - Arrow Hart	Hubbell	Leviton	Pass & Seymour
20A1P	AH1221	HBL1221 or SNAP 1221	1221 or M1221	PS20AC1 or PT20AC1

Toggle Switches	Eaton - Arrow Hart	Hubbell	Leviton	Pass & Seymour
20A 3-way	AH1223	HBL1223 or SNAP 1223	1223 or M1223	PS20AC3 or PT20AC3
20A 4-way	AH1224	HBL1224 or SNAP 1224	1224 or M1224	PS20AC4 or PT20AC4
20A Momentary	1995	HBL1556	1257	1251

2.3 DIMMERS

A. Wall switches shall be as described in the Symbol Schedule on the Drawings and be UL1472 Listed.

B. Acceptable manufacturers and product lines are as follows, where two part numbers are listed the first is a slide-to-off device, for 3-way dimming applications use the second part number:

Dimmers	Leviton	Lutron	Synergy	Wattstopper
120V – 1000W Incandescent	INI10-1LW or IPI10-1LW	NT-1000 or NT-1003P	ISD1000I	CD1103P
120V / 277V 0-10V Fluorescent	IP710-DLW	NTSTV-DV or not available	ISDBC	CD4FB or CD4FB3P
277V – 1200W Line Voltage Fluorescent	IPX12-7LW	NTFTU-103P-277	ISDADEZ	CDFB7277 or CDFB73P277
120V – 400W Electronic Low Voltage	IPE04-1LW	NTELV-600	ISDELV	not available
120V – 1000W Magnetic Low Voltage	INM10-1LW or IPM10-1LW	NTLV-1000 or NTLV-1003P	ISDLV	CDLV1103P

2.4 RECEPTACLES

A. Receptacles shall be as described in the Symbol Schedule on the Drawings.

B. Receptacles shall contain a 1-piece, die stamped (not riveted), brass mounting strap with high-impact, chemical resistant face.

C. 20A Duplex type "Industrial Grade" receptacles shall be UL498 Listed. Refer to Symbol Schedule on Drawings for complete description.

D. Ground fault circuit interrupting (GFCI) receptacles shall be a U.L. 943 and U.L. 498 Listed duplex feed-through type with power/failure indicating LED, and test and reset buttons. Refer to Symbol Schedule on Drawings for complete description.

E. Transient voltage surge suppression (TVSS) receptacles shall be duplex type with damage-alert alarm and indicating light. Receptacles shall meet all appropriate UL1449 and UL498 requirements. Refer to Symbol Schedule on Drawings for complete description.

F. "Hospital Grade" duplex receptacles shall be UL498 Listed and have nickel-plated brass mounting straps. Refer to Symbol Schedule on Drawings for complete description.

G. "Tamper Resistant" duplex safety receptacles shall be UL 498 Listed, and shall utilize a mechanical shutter assembly which requires the presence of an object in both right and left hand contacts to energize the device. Refer to Symbol Schedule on Drawings for complete description.

H. "Weather Resistant" duplex receptacles shall be UL 498 Listed, and have corrosion resistant current carrying metal parts including mounting strap and wire binding screws. Receptacles shall be resistant to cold temperatures, ultraviolet radiation, and accelerated aging due to water infiltration. Refer to Symbol Schedule on Drawings for complete description.

I. Plug tail devices are listed underlined in table below for each device where available. Acceptable manufacturers and product series are as follows:

Device	Eaton - Arrow Hart	Hubbell	Leviton	Pass & Seymour
20A Duplex Receptacles	AH5362 or AH5362M	HBL5362 or SNAP5362	5362 or M5362	PS5362A or PT5362A
20 Amp Tamper Resistant Duplex Receptacle with Two 3.1A Minimum USB Port	TR7756	USB20X2 or SNAP20 USB	T5832	TR5362 USB
20A GFCI Duplex Receptacles	VGF20 or VGF20MOD	GFRST20	7899 or M7899	2095 or PT2095
20A TVSS Duplex Receptacles	5362S or 5362SM	HBL5362SA or SNAP5362S	7380	5362-SP
20A Weather Resistant Duplex Receptacles	WRBR20	5362WR	5362-WR	WR5362
20A GFCI Weather Resistant Duplex Receptacles	WRVGF20 or WRVGF20MOD	GFTWRST20 or GFTWRST20SNAP	7899-WR	2095TRWR
20A Hospital Grade Duplex Receptacles	AH8300 or AH8300M	HBL8300 or SNAP8300	8300 or M8300	8300 or PT8300
20A Hospital Grade Tamper Resistant Duplex Receptacle with Two 3.1A Minimum USB Ports	TR8355	USB8300 or SNAP8300 USB	T5832HG	TR8301 USB
20A GFCI Hospital Grade Duplex Receptacles	VGFH20 or VGFH20MOD	GFR8300HL or GFRST83SNAP	7899-HG or M7899-HG	2095-HG or PT2095HG
20A Hospital Grade Tamper Resistant Duplex Receptacles	TR8300 or TR8300M	HBL8300SGA or SNAP8300TRA	8300-SG or M8300-SG	TR-63H or PTTR63

2.5 COVERPLATES

A. Provide plates for all switches, receptacles, TV outlets, other outlets and blank plates for all unused outlets.

B. Where two or more devices are set at one point, they shall be covered with a common plate.

C. Plates for flush mounted devices shall be high-impact smooth nylon, similar to Hubbell "P" series, color to match wiring device.

D. Plates for devices mounted in surface FS or FD boxes shall be heavy-gauge galvanized stamped steel, Crouse Hinds type DS or Appleton type FSK.

E. Cover for receptacles in wet locations shall self locking vertical flip covers UL listed "suitable wet locations while in use". Clear polycarbonate type shall be Taymac #MM410C for single gang box and #MM2410C for two gang box or equal by intermatic. Cast aluminum type shall be Thomas Betts #CKMGV for single gang box and #2CKG for two gang box or equal by Hubbell. Refer to Symbol Schedule on drawings for complete description.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install wiring devices as indicated on the Drawings, and as described below.

B. Switches and receptacles shall be installed and located as follows, unless noted otherwise on Drawings:

1. Switches: 48" above finished floors.

2. Receptacles: 18" above finished floors generally; 36" above unfinished floors or 6" above counters and work benches (3" above counter backsplash) in kitchens, shops, mechanical equipment rooms and similar areas unless indicated otherwise.

C. In masonry walls, switches and receptacle heights shall be adjusted as required so outlets are at nearest mortar joint to specified height.

D. Where light switches are located adjacent to doors, they shall be installed on "knob" side of door opening, unless indicated otherwise.

E. Where walls have wainscot finish, switch height shall be adjusted as required so switch is either all in wainscot or all in wall above wainscot.

F. Prior to roughing-in outlet boxes, Contractor shall verify from general construction drawings door swings, type of wall finishes and locations for counters and work benches.

G. This section Contractor shall provide material as required to completely install work indicated on the Drawings which is located in mill and casework.

END OF SECTION 26 01 40

SECTION 26 01 51-MOTOR WIRING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Provide equipment, material, labor, and supervision necessary to install wiring and controls for motor driven equipment.

1.3 DESCRIPTION

A. Unless otherwise specified, the Electrical Contractor shall mount and align all starters, safety switches, variable frequency drives, and other related electrical equipment whether specified in this or other sections of this specification, except where such items are factory mounted on the driven equipment. The mounting and alignment of motors, starters, control equipment, etc., for elevators, dumbwaiters, and for equipment for which the feeders are terminated in safety switches as hereinafter specified, are included in the sections of this specification in which the motors, etc., are specified.

B. The Electrical Contractor shall furnish and install power wiring to motor starters and from motor starters to motors. In general, temperature control wiring and other specialized control wiring is not included in this Division. Provide control wiring under this division only where specifically indicated on the drawings.

1.4 CODES AND STANDARDS

A. Installation shall be in accordance with NEC, Articles 300 and 430.

PART 2 - PRODUCTS

2.1 RELATED EQUIPMENT AND MATERIAL

A. The equipment and material related to the wiring of motors should be as called for on the Drawings and as specified in the following Sections:

1. Section 26 01 11 - Conduit Systems
2. Section 26 01 20 - Wire and Cable
3. Section 26 01 55 - Combination Motor Starters
4. Section 26 01 70 - Disconnect Switches
5. Section 26 01 81 - Fuses
6. Section 26 04 10 - Power Factor Correction
7. Section 26 04 50 - Grounding

PART 3 - EXECUTION

3.1 INSTALLATION

A. Unless otherwise specified, all wiring to motors, control equipment and related electrical equipment shall be installed in rigid conduit, IMC or EMT, with flexible metal conduit connections or liquid-tight flexible metal conduit connection at the motor terminations. Conduits shall be sized to accommodate motor feeders, grounding conductors, and control wires, whether or not so indicated on Drawings. Wire sizes shall be as shown, or if not shown, as required by the load served and the NEC.

B. Splices/terminations at motors shall be bolted and removable. Insulate splices in motor terminal boxes with elastic void-filling putty or self-fusing (pad-form) compound followed by half-lapped layers of tape. Tape to a thickness equal to the conductor insulation. Terminating materials shall be Scotchfil and Scotch #23 tape.

C. Prior to final connections, tests and rotation checks shall be made on each motor.

END OF SECTION 26 01 51

SECTION 26 01 52-WIRING EQUIPMENT FURNISHED UNDER OTHER DIVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Furnish materials, tools, labor, and supervision necessary to provide wiring to and connect motors or other electrically served equipment provided under other Divisions.

1.3 STANDARDS AND CODES

A. Except where otherwise required by this Section, the following Standards and Codes shall govern:

1. Branch Circuits: NEC Articles 210 and 220
2. Feeders: NEC Articles 215 and 220
3. Motor Circuits: NEC Article 430
4. Grounding: NEC Article 250

1.4 DESCRIPTION

A. This Section outlines the scope of the work required and references other Sections in which the materials required for wiring equipment are described.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Wiring materials shall conform to the requirements of the following Sections:

1. Section 26 01 11 - Conduit Systems
2. Section 26 01 20 - Wire and Cable
3. Section 26 01 40 - Wiring Devices and Plates
4. Section 26 01 51 - Motor Wiring
5. Section 26 01 55 - Combination Motor Starters
6. Section 26 01 65 - Branch Circuit Panelboards

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide supplementary control devices for equipment, in addition to those supplied by the equipment manufacturer only where specifically indicated on the drawings.

B. Provide power wiring to motor starters and from motor starters to motors. In general, temperature control and other specialized control wiring in not included in this Section. Provide control wiring under this Section only where specifically indicated on the drawings.

C. Each feeder and branch circuit associated with a two-pole or three-pole protective device shall be provided with a separate green insulated equipment grounding conductor. The required equipment grounding conductor shall be sized as shown on the drawings and shall not be smaller than shown in NEC Table 250.122 and shall be installed in a common conduit with the related phase and/or neutral conductors. In the case of parallel feeders, each raceway shall have a full size green insulated equipment ground conductor.

D. In general, motor starting equipment will be furnished and installed by the Electrical Contractor. Where motor starting equipment is furnished by the Supplier of the equipment, the Electrical Contractor shall install the starter and install all required power wiring. Provide control wiring only as specifically indicated on the drawings. In general, three phase motors will be equipped with combination magnetic starters and fractional horsepower single phase motors will be equipped with manual motor starters.

E. Electrical equipment to be connected under this Section shall include, but not be limited to, the following:

1. Heating Equipment
2. Ventilating Equipment
3. Air Conditioning Equipment
4. Plumbing Equipment
5. Food Service Equipment
6. Laboratory Equipment
7. Medical Equipment
8. Elevator Equipment
9. Dumbwaiter Equipment

END OF SECTION 26 01 52

SECTION 26 01 54-FRACTIONAL HORSEPOWER MANUAL MOTOR STARTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Furnish materials, labor, and supervision necessary to install fractional horsepower motor starters as required by the Drawings and this Section.

B. These starters shall typically be installed for single phase motors with ratings of less than one-half horsepower.

1.3 CODES AND STANDARDS

A. Fractional horsepower Starters shall be in accordance with NEMA Standards, sizes and horsepower ratings.

1.4 QUALIFICATIONS

A. Refer to Specification Section 260051, paragraph 1.10 for acceptable manufacturers.

PART 2 - PRODUCTS

2.1 GENERAL

A. Enclosures shall be of the general purpose type except where Drawings call for other type enclosures.

2.2 STARTERS

A. Fractional horsepower manual starters shall include the following devices:

1. Neon pilot light
2. "Quick-make, quick-break" trip-free toggle mechanism
3. Handle guard/Lock-off
4. Melting alloy thermal overload relay

2.3 REMOTELY CONTROLLED SINGLE PHASE STARTERS

A. Remotely controlled single phase starters shall be rated for 1.0HP maximum and 120-240VAC. Starters shall include the following features:

1. NEMA 1 enclosure
2. Hand-Off-Automatic functionality
3. LED for On/Off/Fault indication
4. Padlockable in the off position
5. Solid state adjustable overload protection with manual reset
6. 12-120VAC/DC or dry contact closure for “Run” command input
7. Integral current sensing proof of “Run” output contact

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install starters for motors as indicated on the Drawings.

B. Install laminated (P-Touch type) label or engraved nameplate to indicate load controlled and branch circuit serving the starter.

C. Prior to purchasing starters, obtain from Owner and other Contractors a schedule of motors that will require starters. Notify Engineer immediately of any discrepancies with the Electrical Drawings.

END OF SECTION 26 01 54

SECTION 26 01 55-COMBINATION MOTOR STARTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Furnish materials, labor and supervision necessary to install Combination Motor Starters as required by the Drawings and this Section.

B. Combination starters shall be installed for motors with ratings of one-half horsepower or larger, and rated 200 volts or higher.

C. Starters shall be NEMA sizes as selected by the Contractor as required for the motor horsepower ratings. No starter shall be smaller than NEMA Size 0.

1.3 CODES AND STANDARDS

A. Combination starters shall be in accordance with NEMA Standards, sizes and horsepower ratings.

B. Combination starters for Design E motors larger than 2 horsepower shall be marked as "rated for use with a Design E motor" or have a horsepower rating of not less than 1.4 times that the associated Design E motor.

1.4 QUALIFICATIONS

A. Refer to Specification Section 260051, paragraph 1.10 for acceptable manufacturers.

PART 2 - PRODUCTS

2.1 ENCLOSURE

A. Enclosures shall be of the general purpose type except where Drawings call for other type enclosures.

2.2 DISCONNECT SWITCH

A. Disconnect device shall be a visible blade disconnect switch.

B. Disconnect switch shall be fusible type, with rejection clips for RK1 type fuses.

C. The disconnect handle shall always be in control of the disconnect device with the door open or closed. The disconnect handle shall be clearly marked as to whether the disconnect device is "ON" or "OFF".

D. Disconnect handle shall contain provisions for padlocking in the "OFF" position.

E. The disconnect switch shall be furnished with one auxiliary SPDT contact for use by the Temperature Control Contractor to de-energize remotely powered interlock wiring when the disconnect is in the "OFF" position.

2.3 STARTERS

A. Motor starters shall be FVNR, 3-phase unless noted otherwise on the drawings. Starter size shall be as indicated on drawings. No starter shall be smaller than NEMA Size 0. Each starter shall be furnished with the following devices:

1. “HAND-OFF-AUTO" selector switch in cover.

2. Heavy duty push-to-test red pilot light to illuminate when motor is running.

3. Control power transformer with 120 volt secondary (unless noted otherwise on the drawings). Control transformer primary shall be connected to the load side of the incoming line disconnect fuses and the secondary shall be fused and grounded.
4. Three (3) bi-metal type or solid state thermal overload elements. The starter shall be inoperative if any thermal element is removed. Refer to Section 3.1.B for sizing requirements.
5. Minimum of two NO/NC field convertible auxiliary contacts. Two NO and two NC contacts may be furnished in lieu of convertible contacts.
6. Engraved nameplate on the door describing the equipment controlled.
7. Coil voltage shall be as indicated on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install combination motor starters for motors as indicated on the Drawings.

B. The fuses and overload elements in each starter shall be furnished and installed by the Electrical Contractor. It is the responsibility of the Electrical Contractor to size all fuses and overload elements per the motor nameplate full load amperage (FLA). Coordinate motor nameplate FLA with the Mechanical Contractor and shop drawings.

C. Prior to purchasing starters, obtain from Owner and other Contractors a schedule of motors that will require starters. Notify Engineer immediately of any discrepancies with the Electrical Drawings.

D. Field verify that all motor controllers used in conjunction with Design E motors are marked or sized in full compliance with NEC 430.83.

END OF SECTION 26 01 55

SECTION 26 01 62-DISTRIBUTION SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Provide material, equipment, labor, and supervision as required for the complete installation of switchboards at the locations indicated on the drawings.

1.3 CODES AND STANDARDS

A. Switchgear shall be completely factory assembled, wired and tested before delivery and shall bear UL labels. Designs shall meet NEC and NEMA standards as well as OSHA requirements.

1.4 QUALIFICATIONS

A. Refer to Specification Section 26 00 51, paragraph 1.10 for acceptable manufacturers.

1.5 SUBMITTALS

A. Submittal data for the switchboard shall consist of shop drawings showing technical data necessary to evaluate the equipment, to include dimensions of switchboard cubicles, fabrication materials, bus arrangement, ratings and other descriptive data necessary to describe fully the equipment proposed.

PART 2 - PRODUCTS

2.1 GENERAL

A. This Specification and associated drawings describe free-standing power distribution switchboards with the arrangement and schedule of circuits shown on the drawings.

B. The switchboard shall consist of modular sections bolted together electrically and mechanically to form rigid structures and safely perform the electrical functions for which they are intended.

C. The switchboards shall be arranged for 480V, 480/277V or 208/120V as indicated on the drawings. All busses shall be of the current ratings indicated on the drawings, shall be copper and shall be sized and ventilated for 55°C rise (maximum) in a 40°C ambient temperature (bus density to be sized for a maximum rating of 1000 amperes/square inch).

1. Phase and neutral horizontal through-bus shall be fully rated to match the Switchboard ampacity, as indicated on the drawings.

2. Tapered and derated horizontal bussing shall not be permitted.

D. Phase and neutral bus (main horizontal and through-bus) shall each consist of a single solid copper bus thru 2000 amperes. Parallel conductors for each phase and neutral bus shall be permitted for ampacities exceeding 2000 amperes. Parallel conductors for each phase and neutral bus shall be separated by spacers to provide air insulation around each conductor (parallel bus bars shall not be clamped together).

E. Ground bus shall be copper, 1/4" x 2" and full width of the switchboard.

F. Where required by the drawings, the switchboard shall contain main and ground bus provisions for future distribution sections. The provisions shall include bus bars installed and extended to the extreme side of the section, to allow a future section that requires only a standard bolted splice plates.

G. All bolted bus connections and lug to bus connections shall be made using Belleville washers.

H. Minimum bus bracing and circuit breaker interrupting ratings shall be per ratings shown on the electrical drawings.

I. Main busses and ground bus shall have lugs to accommodate the incoming feeder and ground conductors shown on the drawings

J. Main lugs, sub-feed lugs, neutral/ground bars, and all fusible distribution units and circuit breaker terminals shall be UL listed as suitable for use with 75°C conductors.

K. The switchboard shall be dead front with accessibility as required by the drawings. The framework is to be of code gauge steel, rigidly welded and bolted together to support all cover plates, bussing and component devices during shipment and installation. Formed removable closure plates shall be used on the front and rear. All closure plates are to be screw removable. Ventilating louvers shall be provided when required. The switchboard will have adequate lifting means and be capable of being rolled or moved into its installation position. Exterior and interior metal surfaces of the switchboard shall be finished with baked enamel over an iron phosphate pre-treatment. The enamel finish shall be medium light gray.

L. The main disconnect device, where required, shall be a molded case circuit breaker, solid state circuit breaker, stationary mounted power circuit breaker, draw-out mounted power circuit breaker, bolted pressure contact fusible switch, quick-make, quick-break fusible switch, systems circuit breaker or service protector as indicated on the drawings.

1. Circuit breakers shall be provided with adjustable LSI or LSIG trip units, as indicated on Drawings.

2. Where the main disconnect device is a circuit breaker that serves as secondary protection for a dry-type transformer, provide adjustable high-instantaneous trip setting on the breaker.

M. All draw-out mounted main and/or distribution circuit breakers are to be front and rear accessible and rear connectable. Breakers shall be 100% rated, electrically operated, with adjustable solid state trip settings, and interrupting rating as shown on the drawings.

N. All individually mounted main and/or distribution circuit breakers are to be front and rear accessible and rear connectable. Breakers shall be bolt-on, molded case, manually operated (unless noted otherwise on the drawings), with adjustable solid state trip settings, and interrupting rating as shown on the drawings.

O. All group mounted main and/or distribution circuit breakers are to be totally front accessible and front connectable. Breakers shall be bolt-on, molded case, manually operated (unless noted otherwise on the drawings), with adjustable solid state trip settings, and interrupting rating as shown on the drawings.

P. All branch fusible switches shall be quick-make, quick-break type with visible blades and provisions for current limiting fuses (molded case switches are not acceptable). Switches rated above 600 amperes shall be provided with Class L fuses. Switches 600 amperes and below shall be provided with Class R fuses, unless specifically noted otherwise on the drawings. All fuses shall be furnished and installed by the Electrical Contractor.

Q. Provide ground fault protection for main and/or distribution breakers where required by the drawings and the National Electric Code. Each breaker required to be furnished with ground fault protection shall have adjustable settings (pick-up and delay) and cause of trip indication.

R. Where required by the drawings, furnish and install digital metering with LCD display to provide the following: phase to phase voltages, phase to neutral voltages, phase currents, neutral current, power factor, and total kilowatts Meter shall be furnished with 256 MB of internal memory, onboard web browser (Ethernet)/Modbus/BACnet Communication card. Provide all required potential and current transformers and wiring for same. (Cutler-Hammer PXM 2260 or equal).

S. All switchboard control components shall be permanently identified by the factory in accordance with the submittal drawings (wiring diagrams and equipment layout drawings).

T. All control relays shall be of the enclosed type. Open type relays will not be permitted.

U. All distribution sections shall be fully bussed (spaces shall have bus for future devices).

V. Provide shipping splits in switchboards as required for shipping and installation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Furnish and install switchboards as indicated on the drawings.

B. Set switchboards on 3" high concrete pads in all locations. All top edges of concrete pads shall be chamfered.

C. Provide engraved nameplates for each main and branch device in accordance with the identification requirements of Specification Section 26 00 51.

D. Refer to Specification Section 26 00 52 for Testing Requirements.

E. Refer to Specification Section 26 01 20 for additional information and requirements regarding termination.

END OF SECTION 26 01 62

SECTION 26 01 64-CIRCUIT BREAKER DISTRIBUTION PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Provide material, equipment, labor, and supervision as required for the complete installation of wall mounting circuit breaker distribution panelboards as required by the Drawings and this Specification.

1.3 CODES AND STANDARDS

A. Panelboards shall be completely factory assembled, wired and tested before delivery and shall bear UL labels. Designs shall meet NEC and NEMA standards as well as OSHA requirements.

1.4 QUALIFICATIONS

A. Refer to Specification Section 260051, paragraph 1.10 for acceptable manufacturers.

1.5 SUBMITTALS

A. Submittal data for the panelboard shall consist of shop drawings showing technical data necessary to evaluate the equipment, to include dimensions, fabrication materials, bus arrangement, ratings and other descriptive data necessary to describe fully the equipment proposed.

PART 2 - PRODUCTS

2.1 GENERAL

A. These specifications and associated drawings describe wall mounting circuit breaker distribution panelboards.

B. The panelboards shall be arranged for 480V, 480/277V or 208/120V as indicated on the Drawings. All busses shall be of the current ratings indicated on the drawings, shall be copper and shall be sized and ventilated for 55°C rise (maximum) in a 40°C ambient temperature (bus density to be sized for a maximum rating of 1000 amperes/square inch).

C. Panelboard bus structure shall be provided with main lugs or main switch of the ratings as shown on the Drawings. The bus structure shall accommodate bolted circuit breakers as indicated on the Drawings without modification to the bus assembly.

D. Wiring Terminals: Main lugs, sub-feed lugs, neutral/ground bars, and all circuit breaker terminals shall be UL listed as suitable for use with 75°C conductors.

E. Circuit breakers shall be equipped with individually insulated, braced and protected connectors. The front faces of all circuit breakers shall be flush with each other. Large permanent, individual circuit numbers shall be affixed to each breaker in a uniform position. Tripped indication shall be clearly shown by the breaker handle taking a position between "ON" and "OFF". Provisions for additional breakers shall be such that no additional hardware will be required to add breakers.

1. Circuit breakers shall have an interrupting rating as indicated on the Drawings.

2. Single pole breakers shall be mounted at the top of the panel assembly. Two and three pole breakers shall be mounted at the bottom of the panel, below all single-pole devices and provisions, unless specifically noted otherwise on the drawings.

3. Provisions for additional breakers shall be provided so that no additional connectors or mounting hardware is required to add breakers.

4. Main breakers shall be individually mounted separate from branch breakers. Backfed branch breakers may not be used as main breakers unless specifically noted otherwise on the drawings.

F. Each panelboard, as a complete unit, shall have a short circuit current rating equal to or greater than the integrated equipment rating shown on the Drawings. Panelboards shall be marked with their maximum short-circuit current rating and shall be UL listed.

G. Panelboard assembly shall be enclosed in a steel cabinet. The rigidity and gauge of steel to be as specified in UL Standard 50 for cabinets. The size of wiring gutters shall be in accordance with UL Standard 67. Cabinets to be equipped with latch and tumbler-lock on door of trim. Doors over 48" long shall be equipped with three-point latch and vault lock. All locks shall be keyed alike

1. Panelboard enclosure seams shall be continuously welded.

H. The panelboard interior assembly shall be dead front with panelboard front removed. Main lugs or main breakers shall be barriered on five sides. The barrier in front of the main lugs shall be hinged to a fixed part of the interior. The end of the bus structure opposite the mains shall be barriered.

I. Each panelboard shall have full rated copper ground bars with screw terminal lugs to accept all grounding and bounding conductors. A ground lug capable of terminating a #4 thru 250 MCM conductor shall be provided for each incoming feeder ground conductor, each overcurrent device, each spare overcurrent device and each overcurrent device provision.

J. All distribution sections shall be fully bussed (spaces shall have bus for future devices).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide and install wall mounting circuit breaker distribution panelboards as indicated on the drawings.

B. Provide conductor terminations as indicated on the drawings.

C. Provide engraved nameplates in accordance with the identification requirements of Section 260051.

D. Refer to Specification Section 26 00 52 for Testing Requirements.

E. Refer to Specification Section 26 01 20 for additional information and requirements regarding termination.

END OF SECTION 26 01 64

SECTION 26 01 65-BRANCH CIRCUIT PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Furnish equipment, materials, tools, labor, and supervision necessary to install branch circuit panelboards as specified in this Section and as called for on the Drawings.

1.3 STANDARDS AND CODES

A. Fabrication and installation shall comply with applicable Sections of NEC, Article 408 and NEMA Standards.

B. All panelboards shall be UL listed, labeled, manufactured and tested in accordance with the latest standards of the following:

1. UL 50 – Enclosures for Electrical Equipment, Non-Environmental Considerations

2. UL 67 – Standards for Panelboards

1.4 DESCRIPTION

A. Panelboards described in this Section shall be dead-front, safety type furnished with bolt-on thermal-magnetic molded case circuit breakers for lighting, receptacle and branch circuit applications. Circuit breakers shall have frame and trip ratings as scheduled on the Drawings.

1.5 QUALIFICATIONS

A. Refer to Specification Section 260051, paragraph 1.10 for acceptable manufacturers.

1.6 SUBMITTALS

A. Shop drawings to include fabrication details, lug and bus arrangement, ampere and voltage rating, breaker frame sizes and interrupting ratings.

PART 2 - PRODUCTS

2.1 PANELBOARDS

A. Bussing Assembly and Temperature Rise: Panelboard bus structure and main lugs or main breaker shall have current ratings as shown on the Drawings. Such ratings shall be established by heat rise tests with maximum hot spot temperature on any connector to bus bar not to exceed 50°C rise above ambient. Heat rise test shall be conducted in accordance with Underwriters' Laboratories Standard UL 67. The use of conductor dimensions will not be accepted in lieu of actual heat tests. Bus bar connections to the branch circuit breakers shall be the "distributed phase" or "phase sequence" type. Single phase, three-wire panelboard bussing shall be configured such that any two adjacent single-pole breakers are connected to opposite polarities in such a manner that two-pole breakers can be installed in any location. Three-phase, four-wire bussing shall be configured such that any three adjacent single-pole breakers are individually connected to each of the three different phases in such a manner that two or three-pole breakers can be installed at any location. Current-carrying parts of the bus assembly shall be plated. Main bus ratings shall be as described on the Drawings.

B. A fully rated copper neutral bus shall be provided where three phase/four-wire or single phase/three-wire services are indicated. The neutral bus shall have conductor landing capacity appropriate for the feeder (and bonding jumper, where appropriate) and phase pole count for the panel.

C. A copper equipment ground bus shall be provided in each panel. The bus shall have conductor landing capacity appropriate for the feeder (and neutral bonding, where appropriate) and minimum of 50% of the phase pole count for the panel.

D. Safety Barriers: The panelboard interior assembly shall be dead front type.

E. Cabinets and Fronts:

F. Panelboard assembly shall be enclosed in a hot zinc dipped galvanized steel cabinet. The rigidity and gauge of steel to be as specified in UL Standard 50 for cabinets.

G. Wiring gutters shall be in accordance with UL Standard 67 for panelboards.

H. Fronts shall include hinged front trims, hinged doors with flush, brushed stainless steel, cylinder tumbler-type locks with catches. The flush lock shall not protrude beyond the front of the door. All panelboard locks shall be keyed alike. Doors shall be mounted by completely concealed steel hinges. A metal circuit directory frame (welded to interior of breaker access door) and card with a clear plastic covering shall be provided on the inside of the door (glued-on directory frames are not acceptable). The directory shall be typed to identify the load fed by each circuit. Fronts shall be of code gauge, full finished steel with rust-inhibiting primer and gray baked enamel finish.

1. All multi-section branch circuit panelboards assemblies shall consist of identically sized enclosures, unless specifically noted otherwise on plans.

2. Eaton hinged front trims for ALL applications shall be "LTDD Series Hinged Front Cover" (EZ-Trim is not acceptable).

3. ABB (General Electric) hinged front trims shall be "Front Hinged to Box".

4. Square D hinged front trims shall be "Hinged Front with Hinged Door"

5. Siemens hinged front trims shall be "Hinged Trim" type.

I. Wiring Terminals: Main lugs, sub-feed lugs, neutral/ground bars, and all circuit breaker terminals shall be UL listed as suitable for use with 75°C conductors.

1. Bussing shall be pre-drilled by the manufacturer to accommodate field installable options; sub-feed lugs, through-feed lugs, or sub-feed breakers.

J. Circuit Breakers: Circuit breakers shall be quick-make, quick-break, thermal-magnetic, trip indicating, and have common trip on all multiple breakers. Circuit breakers shall be bolt-on type equipped with individually insulated, braced and protected connectors. The front faces of circuit breakers shall be flush with each other. Large permanent individual circuit numbers shall be affixed to each breaker in a uniform position. Tripped indication shall be clearly shown by the breaker handle taking a position between ON and OFF.

1. Circuit breakers shall have an interrupting rating as indicated on the Drawings.

2. Where a panelboard schedule has been provided on the drawings. The contractor shall assemble all breakers according to schedule so that the installation matches the record drawings.

a. Where specifically directed during construction, documented deviations may apply.

b. Where no panelboard schedule has been provided, single pole breakers shall be mounted at the top of the panel assembly. Two and three pole breakers shall be mounted at the bottom of the panel, below all single-pole devices and provisions.

3. Fire alarm circuit - Breakers that serve as the disconnecting means for any fire alarm circuit, shall conform to the following;

a. Furnished and installed with manufacturer approved breaker lock, able to be secured in the "ON" position.

b. Provide permanent indication or marking of fire alarm circuit, by one of the following methods;

1). A special "fire alarm circuit breaker" with a red breaker handle and factory marking on breaker to read "FIRE ALARM CIRCUIT" as provided by the manufacturer.

2). A permanently affixed factory installed label/nameplate, red with white letters, that reads "FIRE ALARM CIRCUIT". The label shall not damage the breaker or obscure the manufactures markings.

4. Provisions for additional breakers shall be provided so that no additional connectors or mounting hardware is required to add breakers. All spaces listed as provisions on the Panelboard Schedule shall be installed with filler plates that allow installation of future breakers.

5. Main breakers shall be individually mounted separate from branch breakers. Back-fed branch breakers may not be used as main breakers unless specifically noted otherwise on the drawings.

K. Integrated Equipment Rating: Each panelboard, as complete unit, shall have a rating equal to or greater than the integrated equipment rating shown on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Securely anchor panelboards to building structure. Terminate all feeder and branch circuit conductors required by the Drawings.

1. Wireways shall not be installed above branch circuit panelboards. (Raceways shall terminate directly into panelboard tub).

B. The grounded side of each branch circuit shall be fed directly from the neutral bus. The circuit breaker shall feed the ungrounded phase conductor of each branch circuit.

C. Provide engraved nameplates in accordance with the identification requirements of Specification Section 260051, paragraph 1.15.

D. Provide a typed panelboard directory card in each panel as described in Specification Section 260051, paragraph 1.16.

E. Each recessed panelboard shall have one (1) 1" and three (3) 3/4" spare conduits stubbed up into the nearest accessible ceiling space. Raceways from corridor panels shall be stubbed to the corridor side of the panel unless mechanical or other obstructions will prevent or severely limit the use of the raceways in the future.

F. Refer to Specification Section 260120 for additional information and requirements regarding termination.

END OF SECTION 26 01 65

SECTION 26 01 70-DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Provide material, equipment, labor, and supervision as required for the complete installation of fused and non-fused disconnect switches as required by the Drawings and this Specification.

1.3 CODES AND STANDARDS

A. All switches shall be UL listed and labeled. Disconnect switches and accessories shall be designed, manufactured and tested in accordance with the latest applicable standards of the following:

1. UL 98 – Enclosed and Dead-Front Switches
2. NEMA KS-1 – Heavy Duty Enclosed and Dead-Front Switches

1.4 QUALIFICATIONS

A. Refer to Specification Section 260051, paragraph 1.10 for acceptable manufacturers.

1.5 SUBMITTALS

A. Submittal data shall be standard catalog information showing necessary technical data, including switch name (per the drawings), dimensions, conduit entry/exit locations, switch ratings, compatible fuse type (where applicable), and conductor termination size.

PART 2 - PRODUCTS

2.1 GENERAL

A. Disconnect switches shall be heavy duty type enclosed switches of quick-make, quick-break construction.

B. All switches shall be horsepower and I^2t rated.

C. All wiring terminals, neutral bars, and ground bars shall be UL listed as suitable for use with 75°C conductors, and shall be capable of accepting aluminum or copper conductors.

D. The operating handle shall be integral to the enclosure and not the door, directly drive the switch mechanism, and be suitable for padlocking in the "OFF" position with up to 3 padlocks of 5/16" diameter shanks.

E. Defeatable, front accessible interlocks shall be provided to prevent the opening of the door when the switch is in the "ON" position and prevent turning the switch "ON" when the door is open. Door shall include factory installed "ON-OFF" indication.

F. Switches shall be arranged for Class J fuses or contain Class R rejection clips to accept only current-limiting fuses where fused disconnects are specified.

G. The interior shall be easily removable. At least one side wiring gutter shall be clear of any obstructions and moving parts.

H. Enclosures shall be of the following types, unless noted otherwise on the Drawings:

1. NEMA Type 1 in dry locations.
2. NEMA Type 3R (rain-tight) in damp locations, wet locations, or where exposed to weather.

3. NEMA Type 4X (stainless steel) in corrosive locations or where exposed to water spray down.

I. Auxiliary contacts shall be provided for all switches installed on the load side of a VFD, to facilitate remote shutdown of the VFD when the switch is "OFF".

J. Current ratings, voltage ratings, and number of poles shall be as indicated on the Drawings.

K. Each enclosure shall contain a factory ground lug to accept incoming and outgoing ground conductors.

L. Each enclosure shall contain a factory neutral lug to accept incoming and outgoing neutral conductors (where indicated on the Drawings).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Securely anchor disconnect switches to structure or equipment housing and make wiring connections as indicated on the drawings.

B. Furnish and install an engraved nameplate on front trim of each switch ~~enclosure~~ to identify load served, in accordance with the identification requirements of Section 26 00 51.

C. Refer to Specification Section 26 01 20 for additional information and requirements regarding termination.

END OF SECTION 26 01 70

SECTION 26 01 71-SURGE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Furnish materials, labor, and supervision necessary to install surge suppression equipment as required by the Drawings and this Section.

1.3 QUALIFICATIONS

A. Refer to Specification Section 260051, paragraph 1.10 for acceptable manufacturers.

1.4 CODES AND STANDARDS

A. The specified unit shall be designed, manufactured, tested, and installed in compliance with all of the following standards:

1. National Electric Code Article 285
2. American National Standards Institute and the Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.41.2-2002 and C62.45-2002)
3. Canadian Standards Association (CSA)
4. Federal Information Processing Standards Pub. 94(FIPS PUB 94)
5. National Electrical Manufacturers Association (NEMA)
6. National Fire Protection Association (NFPA 70 [NEC])
7. Underwriters Laboratories (UL 1449, Third Edition and 1283)

1.5 WARRANTY

A. The manufacturer shall provide a limited five-year (minimum) warranty from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's Installation, Operation and Maintenance Instructions.

1.6 SUBMITTALS

A. Submittal data shall include dimensions, electrical characteristics, suppression characteristics, and other descriptive data necessary to fully describe the SPD unit as specified on the drawings and in this section.

PART 2 - PRODUCTS

2.1 GENERAL

A. These specifications describe the electrical and mechanical requirements for a commercial grade medium-high hazard, hybrid, high-energy suppression filter system that integrates a Surge Protective Device (SPD) with high-frequency electrical line noise filtering for medium to high exposure applications. The unit shall be connected in parallel with the facility's wiring system per electrical drawings. The unit shall be manufactured by a qualified manufacturer of suppression filter system equipment who has been engaged in the commercial design and manufacture of such products for a minimum of five (5) years.

2.2 SPD'S FOR DISTRIBUTION PANELS:

A. Each unit shall be 208/120 volt or 480/277 volt, as indicated on drawings, three phase 4-wire wye, high-to-medium hazard, hybrid, high-energy, 250,000 ampere per phase class minimum that integrates transient voltage surge suppression (TVSS) with high-frequency electrical line noise filtering.

B. Each unit shall be protected by a fusible disconnect switch or circuit breaker per the electrical drawings. Size of overcurrent protective device to be as specified by manufacturer.

C. The maximum continuous operating voltage (MCOV) of all suppression components utilized in the unit shall not be less than 115% or greater than 125% of the nominal phase-to-neutral operating voltage.

D. Based on ANSI/IEEE C62.41.2-2002's standard 8x20 microsecond current waveform, and in accordance with NEMA Publication No. LS 1-1992, the tested single-pulse surge current capacity, in amps, of the unit shall be no less than as follows:

Four-wire systems			
Mode of Protection	L-N	L-G	N-G
Tested Single Pulse Surge Current	125 KA	125 KA	125 KA

Three-wire systems		
Mode of Protection	L-L	L-G
Tested Single Pulse Surge Current	125 KA	125 KA

E.

F. Each unit shall include protection modules consisting of individually fused metal oxide varistors, EMI/RFI filtering capacitors, and status LED indicators.

G. Each mode of suppression, including N-G, shall be fused with a 200 kaic, UL recognized surge rated fuse and incorporate a thermal cutout device. The unit shall safely reach an end-of-life condition when subjected to fault currents up to 200 KA, including low level fault currents below 5,000 amperes.

H. The unit's published performance ratings shall be the UL 1449, Third Edition Listed suppression voltage ratings.

I. The unit shall be life-cycle tested to protect against and survive no less than 3,000 ANSI/IEEE C62.41.2-2002 Category C3 (20 kv, 10 ka) surges without failing or degrading the UL 1449, Third Edition Surge Suppression Rating by more than 10%. The unit, when installed as part of a facility-wide suppression-filter system, shall be tested and capable of protecting against and surviving no less than 6,000 ANSI/IEEE C62.41.2-2002 Category C3 (20 KV, 10 KA) surges without failing or degrading the UL 1449, Third Edition Surge Suppression Rating by more than 5%.

J. Each unit shall provide a path of extremely low impedance and shall not utilize printed circuit boards, quick type disconnects or small gauge wire in the surge current diversion path. All internal paths shall be low impedance copper conductor or copper bus bar, sized as specified by manufacturer.

K. Each unit shall include a high-frequency extended range tracking filter and shall be UL 1283 Listed as an Electromagnetic Interference Filter.

L. The unit shall include mechanical lugs for each phase, neutral and ground. The lugs shall accommodate up to #4 AWG copper conductor.

M. The unit shall monitor each mode of protection, indicating that the mode is ready, operating, or has failed.

N. The unit shall be integral panel mounted type unless otherwise specified on drawings.

2.3 SPD'S FOR BRANCH CIRCUIT PANELS:

A. Each unit shall be 208/120 volt or 480/277 volt, as indicated on drawings, three phase 4-wire wye, high-to-medium hazard, hybrid, high-energy, 120,000 ampere per phase class minimum that integrates transient voltage surge suppression (TVSS) with high-frequency electrical line noise filtering.

B. Each maximum continuous operating voltage (MCOV) of all suppression components utilized in the unit shall not be less than 115% or greater than 125% of the nominal phase-to-neutral operating voltage.

C. Based on ANSI/IEEE C62.41.2-2002's standard 8x20 microsecond current waveform, and in accordance with NEMA Publication No. LS 1-1992, the tested single-pulse surge current capacity, in amps, of the unit shall be no less than as follows:

Four-wire systems			
Mode of Protection	L-N	L-G	N-G
Tested Single Pulse Surge Current	60 KA	60 KA	60 KA

Three-wire systems		
Mode of Protection	L-L	L-G
Tested Single Pulse Surge Current	60 KA	60 KA

D.

E. Each unit shall include protection modules consisting of individually fused metal oxide varistors, EMI/RFI filtering capacitors, and status LED indicators. The unit's published performance ratings shall be the UL 1449, Third Edition Listed suppression voltage ratings.

F. Each mode of suppression, including N-G, shall be fused with a 200 kaic, UL recognized surge rated fuse and incorporate a thermal cutout device. The unit shall safely reach an end-of-life condition when subjected to fault currents up to 200 KA, including low level fault currents below 5,000 amperes.

G. Each unit shall be life-cycle tested to protect against and survive no less than 3,000 ANSI/IEEE C62.41.2-2002 Category C3 (20 KV, 10 KA) surges without failing or degrading the UL 1449, Third Edition Surge Suppression Rating by more than 10%. The unit, when installed as part of a facility-wide suppression-filter system, shall be tested and capable of protecting against and surviving no less than 6,000 ANSI/IEEE C62.41.2-2002 Category C3 (20 KV, 10 KA) surges without failing or degrading the UL 1449, Third Edition Surge Suppression Rating by more than 5%.

H. Each unit shall provide a path of extremely low Impedance, quick type disconnects or small gauge wire in the surge current diversion path. All internal paths shall be low impedance copper conductor or copper bus bar, sized as specified by manufacturer.

I. The unit shall include a high-frequency extended range tracking filter and shall be UL 1283 Listed as an Electromagnetic Interference Filter.

J. The unit shall include mechanical lugs for each phase, neutral and ground. The lugs shall accommodate up to #4 AWG copper conductor.

K. The unit shall monitor each mode of protection, indicating that the mode is ready, operating, or has failed.

L. The unit shall be integral panel mounted type unless otherwise specified on drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Where internal unit is specified on drawings, it shall be installed in accordance with the NEC and the manufacturer's recommended installation instructions. The unit shall be integral with panelboard, factory bussed and located at the bottom of each panel.

B. Where external unit is specified on drawings, it shall be installed with less than 36" in conductor length, in accordance with NEC and the manufacturer's recommended installation instructions. Connection shall avoid unnecessary bends and not be any longer unless approved by the electrical engineer.

END OF SECTION 26 01 71

SECTION 26 01 81-FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Provide material, equipment, labor, and supervision as required to install the proper size and type of fuse in all fusible equipment, including but not limited to service equipment, switchboards, panelboards, motor control centers, motor starters and miscellaneous fusible disconnect switches.

1.3 CODES AND STANDARDS

A. All fuses shall be UL listed and so labeled.

1.4 QUALIFICATIONS

A. Fuses shall be Bussmann, Littlefuse, or Mersen.

B. Refer to Specification Section 260051, paragraph 1.10.

PART 2 - PRODUCTS

2.1 GENERAL

A. The Electrical Contractor shall furnish and install a complete set of fuses for all fusible equipment on the job. Unless otherwise noted all fuses shall be UL listed, current-limiting and have an interrupting rating of 200,000 RMS amperes symmetrical.

B. All fuses rated 600 amperes or less shall be time-delay current-limiting UL Class J, unless otherwise noted. They shall be:

1. Bussmann Low Peak; LPJ
2. Littlefuse Power Pro; JTD
3. Mersen Amp-Trap 2000; AJT

C. Where specifically called for on the drawings, or required for installation in existing equipment Class RK1 fuses rated at 600 amperes or less shall be time-delay current-limiting as follows:

1. Bussmann Low Peak; LPN-RK (250V), LPS-RK (600V)
2. Littlefuse Power Pro; LLN-RK (250V), LLS-RK (600V)
3. Mersen Amp-Trap 2000; A2D R (250V), A6DR (600V)

D. All fuses rated 601 through 6000 amperes shall be current limiting UL Class L. They shall be:

1. Bussmann Hi-Cap; KRP-C
2. Littlefuse; KLP-C
3. Mersen Amp-Trap; A4BQ

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install proper size and type fuse in all fusible equipment. Arrange fuses so rating information is readable without removing fuse.

B. Fuses shall not be installed until equipment is ready to be energized. All fuses shall be of the same manufacturer to assure coordination.

C. Spare fuses amounting to 20% (minimum three) of each type and rating shall be supplied by the Electrical Contractor. These shall be turned over to Owner upon project completion. Fuses shall be contained and cataloged within the appropriate number of spare fuse cabinets, located in the electrical rooms as indicated on the drawings.

END OF SECTION 26 01 81

SECTION 26 02 16

STANDBY POWER GENERATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The other Contract Documents complement the requirements of this Section. The General Requirements apply to the work of this Section.

1.2 SCOPE

A. The Standby Emergency Generator shall be furnished by the owner, and then turned over to the contractor for installation.

B. Provide material, equipment, labor and supervision as required to install a Standby Emergency Generator, as indicated on drawings.

C. The Electrical Contractor shall include in this contract all costs to review shop drawings, coordinate installation requirements with the supplier, arrange for/supervise field service, testing and training, and completely install the equipment. The Electrical Contractor shall guarantee a complete and operating system in accordance with Section 26 00 51 of the Specification.

D. The Electrical Contractor shall be responsible for all permits, including the State of Ohio Diesel Fuel Storage Tank Permit and Inspection.

E. The Electrical Contractor shall be responsible for providing #2 diesel fuel for generator testing and filling the fuel tank to full capacity prior to turning the system over to the Owner.

1.3 QUALIFICATIONS

A. Standby generator and associated accessories (battery charger, remote annunciator, EPO buttons, etc.) shall be furnished and serviced by one of the following equipment suppliers:

1. Caterpillar #DG300-GC Series. Contact Ohio CAT (Kraig Kirby, tel: 440-838-7130).

2. Kohler #300REOZJ Series. Contact Buckeye Power Sales (Connor Young, tel: 614-315-6963).

3. Cummins. Contact Cummins Sales & Service (Jeff Houlahan, tel: 440-735-2105).

B. Equipment described in these specifications must interface with the Automatic Transfer equipment as specified herein. Refer to Specification Section 26 02 50 for further description.

1.4 SUBMITTALS

A. The Equipment Supplier shall supply complete submittal manuals, including schematics, wiring diagrams, complete parts lists of all major components, plus operating service and preventative maintenance instructions. Submittals shall include the following:

1. Engine generator set including plans and elevations clearly indicating entrance points for each of the interconnections required.

2. Engine generator and control panel.

3. Fuel consumption rate curves at various loads, ventilation and combustion CFM requirements.

4. Exhaust muffler, vibration isolators, battery charger, batteries and battery rack.

5. Weather-resistant, sound attenuated enclosure and sub-base fuel tank.

6. Remote annunciator and EPO pushbuttons.

7. Electrical diagrams including schematic diagrams, and interconnection wiring diagrams for all equipment to be provided.

8. Legends for all devices on all diagrams.

B. Submittals shall include complete coordination of the engine generator system with the automatic transfer switch in the form of a composite wiring diagram which shows all generator controls, and transfer system controls, remote annunciator and emergency off push button.

1.5 STANDARDS

A. Generator shall meet all NFPA 110 requirements for a Level 1 system.

B. Generators shall comply with applicable sections of the NEC, NFPA 101, and NFPA 110.

C. Generator set shall be UL2200 listed.

1.6 MATERIALS AND WORKMANSHIP

A. All materials and parts comprising the units herein specified shall be new and unused, of current manufacturer, and of the highest grade, free from all defects and imperfections affecting performance. Workmanship shall be of the highest grade, in accordance with modern practice. The transfer switch assembly shall be manufactured in the United States by companies currently engaged in the production of such equipment.

1.7 WARRANTY

A. Equipment furnished under this Section shall be guaranteed against defective parts and workmanship under terms of the manufacturer's and dealer's standard warranty. But, in no event, shall it be for a period of less than five years from date of initial start-up of the system. Warranty shall include labor and travel time for necessary repairs at the job site.

PART 2 - PRODUCTS

2.1 STANDBY DIESEL GENERATORS

A. Standby diesel genset shall consist of a 6 cylinder, 4 cycle engine, diesel generator set directly connected to a single bearing synchronous generator, rated at 300 KW (min), 375 KVA, 480/277V, 3Ø, 4W, 60 Hz at 1800 RPM. The engine shall be EPA Tier 3 certified and operate on number 2 diesel fuel. The engine shall be equipped with fuel, lube oil, and intake air filters, lube oil cooler, fuel transfer pump, fuel priming pump, service meter, gear-driven water pump. Genset shall be complete with all standard accessories and shall contain the following factory installed items:

1. Alternator: Permanent magnet exciter to provide 300% rated current for ten (10) seconds. The insulation material shall meet NEMA standards for Class H insulation and shall be UL1449 Recognized and CSA Certified, and shall be vacuum impregnated with epoxy varnish to be fungus resistant. Temperature rise of the rotor and stator shall not exceed 125^0C rise by resistance over 40^0 C ambient.

   a. Provide motor starting capability of 980 SKVA at > 30% instantaneous voltage dip as defined per NEMA MG 1.

2. Output breaker: The generator terminal compartment shall be furnished with one 3-pole manually operated molded-case AC output circuit breaker with adjustable LSI trip units.

   a. Breakers shall be rated for:

      1). 600A with LSI trip unit

      2). 400A with LSI trip unit

b. Breakers shall have two normally-open auxiliary contacts, to close when the breaker is opened.

c. Breakers shall have lug landings suitable for the termination of the copper feeder cables.

3. Digital Voltage Regulator: A three phase sensing generator-mounted, volts-per-hertz-type exciter/regulator shall be provided to match the characteristics of the generator and engine. Voltage regulation shall be + 0.25% from no load to full rated load. Readily accessible voltage droop, voltage level, and voltage gain controls shall be provided. Voltage level adjustment shall be a minimum of + 5%. The solid-state regulator module shall be shock-mounted and epoxy-encapsulated for protection against vibration and atmospheric deterioration.

4. Automatic start/stop controls, 24 volt DC.

   a. Automatic shut-down for high water temperature, low oil pressure, and overspeed shall be provided at the generator.

   b. Provide auxiliary alarm contacts for the following remote monitored conditions:

      1). Approach low oil pressure

      2). Approach high coolant temperature

      3). Low oil pressure

      4). Low coolant temperature

      5). High coolant temperature

      6). Low coolant temperature

      7). Over speed

      8). Engine cranking

5. Gauges: Oil pressure, water temperature and fuel pressure gauges shall be provided at the generator.

6. Starter: A 24 VDC electric starting system with positive engagement shall be furnished.

7. Muffler: Furnish a critical grade silencer, with weather cap.

8. Cooling Radiator: Factory installed engine driven fan cooled vertical core radiator complete with cooling system connections and filled with a solution containing 50% ethylene glycol.

   a. A radiator with blower type fan shall be sized to maintain safe operation at 110 degrees Fahrenheit ambient temperature. Cooling system shall provide proper cooling with no more than 0.5" H_2O back-pressure external to the engine.

   b. The engine cooling system shall be pre-treated by the engine supplier for the inhibition of internal corrosion.

9. Alternator space heater to inhibit condensation.

10. Mounting: The unit shall be mounted on a structural steel sub-base and shall be provided with suitable neoprene rubber vibration isolators.

11. Batteries: Lead acid wet cell storage batteries shall be used in conjunction with the electric starting system provided. The battery shall be provided complete with rack, cables and clamps sized to provide 90 seconds of engine cranking at a battery temperature of 50°F.

12. Battery charger and required accessories to automatically recharge the generator starting batteries. Battery charger shall be automatic equalizing and float charging type.
13. Battery charging alternator.
14. Jacket Water Heater: Unit mounted thermal circulation type water heater incorporating a line-voltage thermostatic switch to maintain engine jacket water to 90 degree Fahrenheit.

2.2 GENERATOR CONTROL PANEL

A. Control panel shall include:

1. A backlight graphical display with text-based alarm/event descriptions.
2. Audible horn for alarm and shutdown with horn silence switch.
3. Remote start/stop control.
4. Local run/off/auto control integral to system microprocessor.
5. Cool-down timer.
6. Speed adjust.
7. Lamp test.
8. Voltage adjust.
9. Voltage regulator V/Hz slope-adjustable.
10. Password protected system programming.

B. Indicating Digital Readouts: As required by NFPA 110 for Level 1 system and the following:

1. AC volts.
2. AC amps.
3. AC frequency.
4. KW.
5. kVA.
6. kVAR.
7. Power Factor.
8. KWH.
9. Exciter voltage and current.
10. DC voltmeter (alternator battery charging).
11. Engine-coolant temperature.
12. Engine lubricating-oil pressure.
13. Engine lubricating-oil temperature.
14. Running-time meter.
15. Ammeter-voltmeter, phase-selector switches.
16. Generator-voltage adjusting rheostat.
17. Fuel tank derangement alarm.
18. Fuel tank high-level shutdown of fuel supply alarm.
19. Generator overload.

20. Engine RPM.

C. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.

1. Overcrank shutdown.
2. Coolant low-temperature alarm.
3. Coolant high-temperature alarm.
4. Coolant high-temperature shutdown.
5. Low coolant level.
6. Loss of coolant shutdown.
7. Control switch not in auto position.
8. Battery-charger malfunction alarm.
9. Battery low-voltage alarm.
10. Battery high-voltage alarm.
11. Low oil pressure warning.
12. Low oil pressure shutdown.
13. Overspeed shutdown.

D. The control panel shall be equipped with BACNET communications capabilities for tie-in to building automation system. Coordinate with the Temp Controls Contractor.

1. The following readouts shall be visible through or alerted to the BAS system:
    a. Generator Running
    b. Generator summary alarm
    c. Fuel level
    d. Control switch not in auto position
    e. Battery charger AC failure
    f. Battery voltage
    g. Low engine temperature
    h. High engine temperature
    i. Fail to Start
    j. Overspeed
    k. Low coolant level
2. The following shall be able to be initiated through the BAS system:
    a. Generator remote test start
    b. Generator exercise cycle with transfer of ATS

E. Generator Alarm/Shutdown

1. Generator over voltage.
2. Generator under voltage.
3. Generator over frequency.

4. Generator under frequency.
5. Generator reverse power.
6. Generator overcurrent.

F. Voltage Regulator Alarm/Shutdown

1. Loss of excitation alarm/shutdowm.
2. Instantaneous over excitation alarm/shutdown.
3. Time over excitation alarm/shutdown.
4. Rotating diode failure.
5. Loss of sensing.
6. Loss of PMG.

G. Generator exerciser:

1. Programmable cycle timer that starts and runs the generator for a predetermined time. The timer shall use 14 user-programmable sequences that are repeated in a 7-day cycle. Each sequence shall have the following programmable set points:
   a. Day of week.
   b. Time of day to start.
   c. Duration of Cycle.

H. "Generator Stop" pushbutton on control panel, inside weather resistant housing.

2.3 WEATHER RESISTANT HOUSING/FUEL TANK

A. The generator and all associated equipment shall be housed in a Level 2 sound attenuated, weather-resistant outdoor enclosure containing and enclosing the entire generator assembly. Housing shall be aluminum or 14 guage steel construction with removable side panels and hinged doors. The housing shall provide adequate cooling and combustion air to allow for operation with the door closed and all panels assembled.

1. A critical type muffler shall be installed within-in housing with a rain cap installed on the muffler exhaust pipe. Sound rating of unit shall be 75 dba (maximum) at 23'-0".
2. Enclosure design shall vertically direct radiator discharge air. Due to site restrictions, horizontal radiator discharge shall not be acceptable. The enclosure shall have factory painted finish.

B. The enclosure shall be furnished with the following additional items:

1. Interior Lights with Switch: Factory-wired, vapor-proof-type LED fixtures within housing; arranged to illuminate controls and accessible interior. Provide switch at all access doors.
   a. Exterior wall packs, furnished and installed by E.C. per the drawings, shall be switched with the interior lights.
2. Convenience Outlets: Factory wired, GFCI duplex receptacle, two required.

C. The assembly shall sit on a U.L. 142 listed double wall diesel fuel tank with leak detector and all accessories required to meet Ohio Rule 34. The tank shall be sized to operate the generator for 48 hours at rated full load. Tank shall minimally include the following:

1. Low fuel level switch
2. Leak detection switch

3. Fuel level gauge
4. 5 gallon spill container on fuel fill nozzle
5. High fuel alarm panel
6. Vent extending 12'-0" above grade.
7. Generator set/tank dimensions shall not exceed 21'"L x 8'-0"W.

D. Equipment supplier shall perform on site fuel tank pressurization test as required by Ohio Rule 34.

2.4 REMOTE ANNUNCIATOR

A. Provide a remote annunciator to meet the requirements of NFPA 110, Level 1. The remote annunciator shall provide remote annunciation of all points listed here-in and shall incorporate ring-back capability so that after silencing the initial alarm, any subsequent alarms will sound the integral horn. Provide alarm indication for the following:

1. Low oil pressure
2. High coolant temperature
3. Low coolant level
4. Overspeed
5. Overcrank
6. Emergency stop depressed
7. Approaching high coolant temperature
8. Approaching low oil pressure
9. Low coolant temperature
10. Low voltage in battery
11. Control switch not in auto position
12. Battery charger AC failure
13. High battery voltage
14. PS supplying load
15. Low fuel level
16. Fuel tank leak

B. The remote annunciator shall be provided with the following additional features:

1. Lamp Test Pushbutton
2. Alarm Mute Pushbutton with ring back feature for subsequent alarms
3. Normal/Run Control Switch
4. Backbox and trim for surface mounting.

2.5 EPO BUTTONS

A. Provide one EPO button (emergency stop pushbutton) for remote mounting on exterior housing of Triple Switch TRS-1, to shutoff generator. EPO button shall be a Pilla Model #ST120SN4XS304 NEMA 4X surface mounted break glass station with pushbutton, momentary contact and "Emergency Generator Stop" legend.

2.6 SPARE PARTS

A. Spare fuses amounting to 10% (minimum two) of each type and rating installed for control panel, and battery charger, control power transformers and meters shall be supplied by the Electrical Contractor.

B. Spare indicating lights amounting to one per each type installed shall be supplied by the Electrical Contractor.

C. Spare filters, one set each of lubricating oil, fuel and combustion air.

D. Spare equipment shall be turned over to Owner upon project completion. Equipment shall be contained in protective package and labeled.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Electrical Contractor shall review all installation instructions to determine the exact extent of labor required for receiving, setting, and installing prior to submittal of bid.

B. The Electrical Contractor shall install generator, and all associated accessories per the manufacturer's installation instructions.

C. The Electrical Contractor shall make all required wiring connections for generator and all generator accessories.

D. Generator shall be set on a concrete pad furnished by the Electrical Contractor.

E. A factory trained representative shall supervise the Electrical Contractor's installation.

F. Exact generator locations and associated conduit rough-in locations shall be determined by the Electrical Contractor based on approved manufacturer's shop drawings.

G. The Electrical Contractor shall apply for a Fuel Storage Tank Permit with the State of Ohio and arrange for inspection and witness test of tank pressurization test. Contact the Ohio Department of Commerce, State Fire Marshal Division, telephone 614-728-5460.

H. The Electrical Contractor shall be responsible for providing #2 diesel fuel for generator testing and filling the fuel tank to full capacity prior to turning the system over to the Owner.

3.2 SYSTEM START-UP

A. On completion of the installation, start-up shall be performed by the engine manufacturers' factory trained service representative.

3.3 TESTING

A. Manufacturer to perform on-site load bank testing and system commissioning in the presence of the Owner's representative.

B. Load bank testing shall be performed on engine for a period of four (4) hours under full load.

C. In the event of any failure, testing shall be restarted unless waived in writing by the Owner.

D. Equipment supplier shall perform on site fuel tank pressurization test as required by Ohio Rule 34.

3.4 OPERATION AND MAINTENANCE MANUALS

A. Equipment Supplier shall furnish to the Owner operation/maintenance manuals as described in the Division 1 Specifications.

B. Manuals shall include Index. Each manual shall provide operating instructions, maintenance manuals, spare parts listing, copies of warranties, wiring diagrams, inspection procedures and shop drawings on all equipment and systems.

3.5 TRAINING

A. Upon completion of the on-site testing and system acceptance the manufacturer shall provide the following:

1. Operation and maintenance instruction manuals. Submit operation and maintenance manuals two (2) weeks prior to on-site operating training.

2. Two hours of on-site operation training during which all routine operation, testing and maintenance procedures are explained. (Operation and maintenance manuals shall be available to Owner's staff during training).

END OF SECTION 26 02 16

SECTION 26 02 50-AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Automatic transfer switches shall be furnished by the owner, and then turned over to the contractor for installation.

B. Provide labor and material necessary to install automatic transfer switches each of the latest commercial type and design as shown on the drawings and as specified herein.

C. The Electrical Contractor shall include all costs to review and submit shop drawings, arrange for field service and testing, coordinate equipment requirements with the supplier, and completely install the equipment. The Electrical Contractor shall guarantee a complete and operating system in accordance with Section 26 00 51 of the Specification.

D. Equipment Suppliers MUST submit a compliance review response to these specifications. The review shall be paragraph by paragraph designating specification Compliance with a "C", Deviation with a "D", or Exception with an "E". The reason for each proposed Deviation and Exception shall be given along sufficient detail to clearly explain/show all deviations and exceptions. Failure to submit a line-by-line compliance review response may result in rejection of the bid proposal.

1.3 QUALIFICATIONS

A. The transfer switch assemblies shall be either:

1. Russelectric #RTS-03 Series. Contact Arthur N. Ulrich Company (Bill Ulrich, tel: 614-927-8244).

2. ASCO #7000 Series. Contact OhioCAT (Kraig Kirby, tel: 440-838-7130).

B. Transfer switches shall be provided with UL 3 cycle (0.05 second) withstand and close-on ratings. Ratings shall be based upon "any breaker" and not require a specific upstream overcurrent protective device to achieve the required short circuit rating. Transfer switches that are provided without ratings shall not be acceptable.

1.4 SUBMITTALS

A. The Contractor shall supply a single combined electronic PDF file containing

1. System configuration with single-line diagrams.

2. Equipment weight and dimensions.

3. Detailed layouts of customer power and control connections.

4. Interconnection wiring diagrams showing conduit wiring with terminal numbers.

B. Submittals shall be specific to the type of equipment being supplied, generic drawings are not acceptable.

C. Where the manufactures documentation identifies optional equipment, features, or accessories, the contractor or manufacturer's representative shall markup the electronically document to clearly identify that options have been either selected or excluded.

D. The equipment supplier shall furnish three (3) hard copies of installation, operation, and maintenance manuals to the Owner after delivery of the equipment.

1.5 MATERIALS AND WORKMANSHIP

A. All materials and parts comprising the units herein specified shall be new and unused, of current manufacturer, and of the highest grade, free from all defects and imperfections affecting performance. Workmanship shall be of the highest grade, in accordance with modern practice. The transfer switchboard and transfer switch shall be manufactured in the United States by companies currently engaged in the production of such equipment.

1.6 WARRANTY

A. The equipment manufacturer shall warranty all equipment against defects in workmanship and materials for 60 months. Labor and travel expenses for any necessary repairs shall be included for the first 24 months; the remaining 36 months shall provide replacement parts coverage. Warranty shall commence after substantial completion or 6 months, whichever occurs first.

PART 2 - PRODUCTS

2.1 TRANSFER SWITCH

A. Transfer switch assembly shall be listed under UL-1008 for use on emergency systems. The switches shall be capable of switching all classes of loads and shall be rated for continuous duty when installed in a non-ventilated enclosure.

B. The transfer switch shall be seismic certified, capable of operating successfully after being subjected to a minimum IBC 200% g Earthquake Test.

C. The automatic transfer switch shall be capable of transferring successfully in either direction with 70% of rated voltage applied to the switch terminals.

D. The automatic transfer switch shall be wall mounted open transition type (amperage and number of poles as indicated on the drawings) with dual operator automatic transfer mechanism.

E. Transfer switch shall be double throw, dual-operator type, momentarily energized and connected to the transfer mechanism by a simple over-center linkage to provide quick-break/quick-make operation when operated electrically or manually. Minimum transfer time between sources shall be 400 milliseconds.

1. Single operator or overlapping neutral transfer switch mechanisms are not acceptable.

2. Dual operator transfer switches shall allow motor and transformer loads to be de-magnetized before transfer and re-energized with normal inrush currents

F. The normal and emergency contacts on the transfer switch shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be mechanically held in position in both the normal and emergency positions without the use of hooks, latches, magnets, or springs; and shall be silver-tungsten alloy. Interlocked molded case circuit breakers or contactors are not acceptable. Main contacts on all switches shall be segmented and shall have separate arcing contacts with magnetic blowouts for positive arc-quenching and maximum contact life.

G. All open transition transfer switches shall be equipped with a safe manual operator designed to prevent injury to operating personnel. The manual operator shall provide the same contact to contact transfer speed as the electrical operator to prevent a flash-over from switching the main contacts slowly. Manual operation shall not require prior disconnection of electrical operators or control wiring and shall be safe even if the electrical operator becomes energized during manual operation. The manual operator shall be external type, operable through the door of the enclosure. Safe manual transfer shall be possible under all load conditions, either energized or non-energized.

H. All bolted bus connections shall utilize compression type Belleville washers.

I. The transfer switches shall be UL listed in accordance with UL 1008 for 3 cycle close and withstand ratings. The minimum UL listed 3 cycle close and withstand ratings at 480 VAC shall be 42 KAIC.

J. All operating mechanisms shall be metallic. Plastic or phenolic type components are not acceptable.

K. Assembly shall contain factory furnished mechanical lugs for each line and load connection. Lugs shall accommodate feeder conductors as indicated on the drawings.

L. The transfer switch shall be provided with a microprocessor-based control system to control and monitor all operational functions of the transfer switch and power monitoring.

1. Power monitoring shall include voltage, current, power and frequency.

M. Each transfer switch shall minimally include the following:

1. Adjustable 0-6 second time delay before engine starting (factory set at 3 seconds).
2. Adjustable 0-9999 time delay on transfer from normal to emergency (factory set at 3 seconds).
3. Adjustable 0-9999 second time delay on re-transfer to normal source (factory set at 300 seconds).
4. Adjustable 0-9999 second time delay to control contact transition time on transfer to either source (factory set at 1 second).
5. Adjustable 0-9999 second time delay to control engine overrun time after re-transfer to normal source (factory set at 300 seconds).
6. Engine start relay to initiate engine start when normal power fails.
7. LED status light to indicate switch in normal position.
8. LED status light to indicate switch in emergency position.
9. Lamp test switch.
10. Two auxiliary contacts on main shaft to close when switch is in normal power position (wired to terminal strip).
11. Two auxiliary contacts on main shaft to close when switch is in emergency power position (wired to terminal strip).
12. Three-phase over/under voltage, over/under frequency, phase sequence, and phase differential monitoring on normal and emergency sources.
13. Integral controller central processing unit with self-diagnostics.
14. Real-time clock (date and time) with nickel-cadmium battery back-up.
15. Color graphical display to indicate system status and keypad to allow access to the systems (password protected).
16. Auxiliary contacts to indicate switch position. This readout shall be monitored by the BAS system. Coordinate with the Temperature Controls Contractor.

N. The controller shall minimally store the following data in accessible memory:

1. Number of hours switch is in emergency power position (since last reset).
2. Number of hours emergency power is available (since last reset).
3. Total transfers in either direction (since last reset).
4. Date and time of last four source failures.

5. Date and time of last test/exercise period.
6. Date and time of last record reset

2.2 SERVICE CONTRACT

A. The Equipment Supplier shall include a 1 (one) year maintenance service agreement as part of the base bid. The agreement shall commence upon Owner's acceptance of the generator installation and include one preventative maintenance visit at the end of the year. Equipment Supplier shall include an outline of services to be provided in this agreement with his proposal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All interconnect wiring integral to equipment shall be provided by the equipment supplier. All required field wiring shall be provided by the Electrical Contractor.

B. Transfer Switch manufacturer shall furnish a competent field service technician to assist in placing the system in operation and instruct personnel in its proper use. This service includes a minimum of one visit by the field service engineer as follows:

1. Installation start-up, and testing, including all testing procedures defined in section 3.02 of this specification section.

3.2 TESTING

A. The Electrical Contractor and manufacturer's field service technician shall perform all on-site system testing and system commissioning in conjunction with testing of the engine generator set in the presence of the Owner's representative.

B. Prior to system start-up, all system control and alarm functions shall be tested and verified by the contractor and manufacturer's service technician. After all testing is completed, the Contractor shall submit a letter stating all system requirements are fully operational and comply with the design.

3.3 TRAINING

A. Upon completion of the on-site testing the manufacturer shall provide the following:

1. Operation and maintenance manuals.
2. Two hours of on-site operation training during which all routine operation, testing and maintenance procedures are explained.

END OF SECTION 26 02 50

SECTION 26 04 50-GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Provide material, equipment, labor, and supervision as required for the complete installation of grounding conductors and fittings.

1.3 CODES AND STANDARDS

A. Except where otherwise required, the following codes shall govern:

1. NEC, Article 250
2. NEC, Article 517 (for Health Care Facilities only)
3. NFPA 101
4. UL 467 – Grounding and Bonding Equipment

PART 2 - PRODUCTS

2.1 GENERAL

A. Service ground conductors and grounding conductors installed below slab on grade shall be bare stranded copper.

B. All other grounding conductors shall be copper with Type TW, THW or THWN green insulation.

C. Ground rods shall be "Copperweld" as manufactured by the following and shall be of the sizes indicated on the drawings.

1. Joslyn
2. Erico, Inc
3. Copperweld, Inc
4. O-Z Gedney
5. Thomas & Betts

PART 3 - EXECUTION

3.1 INSTALLATION

A. Metallic conduit system shall be electrically continuous throughout.

B. All motors and metal frames of all electrical equipment shall be grounded.

C. System neutral conductor shall be identified throughout the building.

D. All cord connected electrical equipment frames shall be grounded to the conduit system through a grounding conductor in the cord.

E. Each feeder shall be provided with a separate green insulated equipment grounding conductor. The required equipment grounding conductor shall be sized as shown on the drawings and shall not be smaller than shown in NEC Table 250.122 and shall be installed in a common conduit with the related phase and/or neutral conductors. In the case of parallel feeders, each raceway shall have a full size green insulated equipment ground conductor.

F. A single green insulated equipment grounding conductor may be run with multiple phase conductor groups in a common raceway which serve wiring devices with shared neutrals and multipole breakers in compliance with NEC Article 210.4. The required equipment grounding conductor shall be sized as shown on the drawings and shall not be smaller than shown in NEC Table 250.122 and shall be installed in a common conduit with the related phase and/or neutral conductors.

G. Single phase branch circuits required for 120 volt and 277 volt lighting, receptacles, and motors shall consist of phase, neutral and grounding conductors installed in a common metallic conduit.

1. Flexible metallic conduit equipment connections utilized in conjunction with the above single-phase branch circuits shall be provided with suitable green insulated equipment grounding conductors connected to approved grounding terminals at each end of the flexible conduit.

2. Single phase branch circuits installed in non-metallic conduits shall be provided with a separate green insulated grounding conductor as hereinbefore specified.

H. For Health Care Facilities, in areas used for invasive procedures (operating Rooms, C-Section Rooms, etc.), all non-current carrying conductive surfaces of fixed electrical equipment shall be grounded by an insulated copper conductor, sized in accordance with Table 250.66.

I. For Health Care Facilities, in patient-care areas are served by more than one distribution power panel, the reference ground buses in the panels shall be bonded together by a No. 10 insulated copper conductor.

J. Furnish and install driven ground rods and grounding conductors as indicated on the drawings.

K. All concealed connections shall be welded with "Cadweld" (or equal by "Thermoweld") fittings. Exposed connections shall be bolted to equipment bus using compression type lugs.

L. Furnish and install all required grounding conductors and fittings as delineated in National Electric Code Article 250.

END OF SECTION 26 04 50

SECTION 26 04 61-DRY TYPE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Provide equipment, materials, labor, and supervision necessary to install dry type distribution transformers as required by the Drawings and this Section.

1.3 QUALIFICATIONS

A. Refer to Specification Section 26 00 51, paragraph 1.10 for acceptable manufacturers.

1.4 CODES AND STANDARDS

A. Transformers shall be UL listed for specified temperature rise and must meet NEMA ST-20 and DOE 2016 energy efficiency standards.

1.5 SUBMITTALS

A. Submittal data shall include dimensions, weight, electrical characteristics, KVA and sound ratings, name (as shown on the Drawings), and other descriptive data necessary to fully describe the transformers.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Transformers shall be furnished with KVA ratings, electrical characteristics and tap arrangements as indicated on the Drawings and as specified herein:

1. Transformers 25 KVA and larger shall have a minimum of seven (7) 2-1/2% full capacity primary taps (2 above and 4 below rated nominal). Exact voltages and taps to be as described on the drawings.

2. Transformers 15 KVA and above shall be rated for 115°C maximum (or as indicated on drawings) temperature rise above 40°C ambient. Insulating materials shall be in accordance with NEMA ST20 standards for a 220°C UL component recognized insulation system.

3. Transformer coils shall be of the continuous wound construction and shall be impregnated with non-hygroscopic, thermo-setting varnish. Materials used must have one year (minimum) of proven field usage. Accelerated laboratory tests are not acceptable in lieu of actual field experience.

4. Cores shall be constructed of high grade, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point. The core laminations shall be clamped together with steel angles. The completed core and coil shall then be bolted to the enclosure base but isolated from the base by means of rubber vibration-absorbing mounts. There shall be no metal-to-metal contact between the core and coil and the enclosure. For transformers 500 KVA and smaller, the vibration isolating system shall be designed to provide a permanent fastening of the core and coil to the enclosure. Sound isolating systems requiring the complete removal of all fastening devices will not be acceptable.

5. Transformers 15 KVA and larger shall be in heavy gauge, sheet steel ventilated enclosure. The ventilating openings shall be designed to prevent accidental access to live parts in accordance with UL, NEMA, and NEC Standards for ventilated enclosures.
6. The entire transformer enclosure shall be degreased, cleaned, phosphatized, primed, and finished with gray baked enamel.
7. The maximum temperature of the top of the enclosure shall not exceed 35°C rise above a 40°C ambient.
8. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable NEMA, IEEE, and ANSI Standards.
9. Sound levels shall be certified by the manufacturer not to exceed the following when tested per NEMA and ANSI Standards:
   a. 15 to 50 KVA - 45 dB
   b. 51 to 150 KVA - 50 dB
   c. 151 to 300 KVA - 55 dB
   d. 301 to 500 KVA - 60 dB

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set floor mounted transformers on 3" high concrete pads in all locations.

B. All transformers shall have minimum rear and side clearances of 6”, or per manufacturer recommendations (whichever is greater) from adjacent obstructions.

C. Mount floor mounted transformers on rubber-in-shear vibration isolators. Suspend ceiling suspended transformers from structure with 1/2" steel rods with rubber-in-shear vibration isolators. Install 1" thick neoprene and cork vibration isolation pad between transformer and walls, for wall mounted transformers.

D. Make conduit connections with not less than 24" length of flexible conduit.

E. Provide engraved nameplate for each transformer in accordance with the identification requirements of Section 26 00 51.

F. Refer to Specification Section 26 01 20 for additional information and requirements regarding termination hardware.

END OF SECTION 26 04 61

SECTION 26 05 01- LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Provide lighting fixtures, accessories, labor, and supervision necessary to install a complete Lighting System as required by the Drawings and this Section.

1.3 CODES AND STANDARDS

A. Except where otherwise required by this Section, the following Standards and Codes shall govern:

1. NEC, Article 410
2. IESNA
3. UL Listed

1.4 SUBMITTALS

A. Submit catalog cuts giving complete description of fixtures to include photometric curves and data, dimensions, features, accessories, and method of installation. All cuts shall be submitted at one time, bound in separate sets having 1 cut of each fixture in each set.

1. A complete description (ratings, manufacturer and catalog number) of the ballast contained within each compact fluorescent, fluorescent and HID fixture shall be included with the fixture submittals.

1.5 QUALIFICATION

A. Lighting fixtures shall be furnished as scheduled on drawings.

PART 2 - PRODUCTS

2.1 FLUORESCENT FIXTURES

A. Fluorescent fixture housings shall be die formed of cold rolled steel of not less than 20 gauge. Construction shall provide an approved method of locking the lens or shielding in place. Enamel finish for light reflectance shall have a hardness between H and 3H. Before enamel is applied, the metal shall be cleaned and prepared by "Bonderizing" or an equivalent process.

B. Plastic lenses for fluorescent fixtures shall be 100% virgin acrylic, non-hogged type, not less than .125" overall thickness with a minimum lens weight of 8.0 ounces per square foot.

C. Temperature around ballast and in fixture housing shall not exceed 90°C with ambient room temperature of 27°C.

D. Unless specifically scheduled otherwise on Drawings, all fluorescent ballasts shall be electronic programmed rapid start ballasts shall be non-hybrid high frequency type. Ballasts shall be Advance "Optanium" series, Sylvania "Quicktronic Prostart" Series, Universal Lighting Technologies "AccuStart" Series, or GE "Ultrastart" Series with the following minimum features:

1. All electronic rapid start design with class P thermal protection.
2. Total harmonic contribution less than 10%.

3. Unless a specific ballast voltage is specified, ballast shall automatically detect and operate from a voltage range of 120V thru 277V +/- 10% with no damage to the ballast.
4. Programmed soft start.
5. Parallel operation of lamps.
6. T5 and compact fluorescent lamps shall have integral end of lamp life ballast protection.
7. Five year warranty.
8. Maintain lamp filaments at full temperature.
9. Crest factor less than 1.7.
10. Ballast factor greater than 85%.
11. Class A sound rating.

E. Magnetic fluorescent ballasts, where scheduled on the drawings, shall be Advance Mark III Energy Saving Type, or equivalent by SLI Lighting (Valmont) or Universal Lighting Technologies, Inc. (Magnetek).

F. Fluorescent dimming ballasts for two wire medium bipin lamp sockets shall be full range type (1%-100%). Lutron Type FDB or HL3.

G. Ballasts for remote mounting shall be furnished with NEMA 1 enclosures.

H. Recessed fixtures in plaster ceilings shall be furnished with plaster frames.

I. Prior to placing orders for recessed fluorescent fixtures, verify the types of ceilings and suspension systems that have been approved for the project and order fixtures with accessories as required to fit in the approved ceilings.

J. Cove lighting shall consist of staggered strip style fluorescent fixtures. Fixture units shall be one or two lamp as specified in the fixture schedule and field assembled by use of fixtures that are nominal 24" and 48" lamp units.

2.2 INCANDESCENT FIXTURES

A. Glassware for fixtures shall be high quality with not less than 65% efficiency in light transmission.

B. Recessed fixtures shall be furnished with gaskets, so designed and installed that they will completely eliminate light leakage between flanges and ceilings.

C. Fixtures shall be furnished with integral thermal overload protection and be so identified as thermally protected.

2.3 METAL HALIDE FIXTURES

A. Open type metal halide fixtures specified for use with B, BD, BT, ED, ET or R style lamp bases shall utilize medium base EX26 and mogul base EX39 sockets which will only accept ANSI type-O (OPEN) metal halide lamps.

B. Open type metal halide fixtures specified for use with PAR type lamps shall utilize standard medium and mogul base sockets.

C. Enclosed type metal halide fixtures can be equipped with type-E, type-S or type-O lamps.

D. All metal halide fixtures located in indoor sporting areas, multi-purpose rooms, and other indoor areas subject to physical damage, shall contain glass or plastic U.V. attenuating lenses.

2.4 LED FIXTURES

A. General:

1. Luminaire manufacturer shall have a minimum of five (5) years' experience in the manufacture and design of LED products and systems and no less than one hundred (100) North American installations.
2. Unless otherwise specified, all LED luminaires and power/data supplies shall be provided by a single manufacturer to ensure compatibility.
3. All components, peripheral devices and control software are to be provided by and shall be the responsibility of a single entity. All components shall perform successfully as a complete system.
4. Include all components necessary for a complete installation. Provide all power supplies, synchronizers, data cables, and data terminators for a complete working system.
5. All LED sources used in the LED luminaire shall be of proven quality from established and reputable LED manufacturers and shall have been fabricated after 2007.

B. Warranty:

1. System shall carry a full warranty for five (5) years. Manufacturer shall be responsible for cost of shipping and labor to replace any component of the system that fails within 2 years of installation.

C. Products and Components – Performance

1. LED luminaires and components shall be UL listed or UL classified.
2. All LED components shall be Restriction of Hazardous Substance Directive (RoHS) compliant.
3. LED luminaires shall be tested by a certified testing agency and shall comply with IESNA LM-79 approved method for electrical and photometric measurement of solid-state lighting products.
4. LEDs shall comply with ANSI/NEMA/ANSLG C78.377-2008 – Specifications for the Chromaticity of Solid-State Lighting Products. Color shall remain stable throughout the life of the lamp.
5. LEDs shall comply with IESNA LM-80 and TM-21 – Standards for Lumen Maintenance of LED Lighting Products
6. White LEDs shall have a rated source life of 50,000 hours under normal operating conditions. RGB LEDs shall have a rated source life of 100,000 hours. LED "rated source life" is defined as the time when a minimum of 70% of initial lumen output remains.
7. Luminaire assembly shall include a method of dissipating heat so as to not degrade life of source, electronic equipment, or lenses. LED luminaire housing shall be designed to transfer heat from the LED board to the outside environment. Luminaire housing shall have no negative impact on life of components.
8. LEDs shall be adequately protected from moisture or dust in interior applications.
9. For wet and damp use, LED-based luminaires itself shall be sealed, rated, and tested for appropriate environmental conditions, not accomplished by using an additional housing or enclosure. Such protection shall have no negative impact on rated life of source or components, or if so, such reductions shall be explicitly brought to the attention of the designer. Such luminaires shall be marked "Suitable for Wet Locations" and "Suitable for Damp Locations", respectively, in accordance with Article 410 of the NEC.

10. For corrosive environments, LED-based luminaires itself shall be sealed, rated, and tested for appropriate environmental conditions, not accomplished by using an additional housing or enclosure. Such protection shall have no negative impact on rated life of source or components, or if so, such reductions shall be explicitly brought to the attention of the designer. Such luminaires shall be marked “Corrosion Resistant” or “Vapor-tight”, in accordance with Article 410 of the NEC.
11. All hardwired connections to LED luminaires shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.
12. The LED luminaire shall be operated at constant and regulated current levels. LEDs shall not be overdriven beyond their specified nominal voltage and current.
13. RGB LED luminaires shall utilize an equal combination of high brightness red, blue and green LEDs, unless otherwise noted, to provide up to 16.7 million additive RGB colors and shall be capable of at least 8-bit control.
14. Power / data supply shall have the following:
    a. Supply shall be internally fused for overload and short circuit protection.
    b. Supply outputs shall have current limiting protection.
    c. Supply shall provide miswiring protection.
    d. Supply shall have power factor correction.
    e. Supply shall provide connections that are conduit-ready or clamp-style connections in the case of low-voltage wiring.
    f. Supply shall be UL listed for Class 1 or Class 2 wiring

2.5 LAMPS

A. All fluorescent lamps shall be 80 CRI (minimum), low-mercury type ("Green Tip") designed to pass the Federal TCLP criteria for classification as non-hazardous waste. Comply with EPA's Toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL Standards.

B. All metal halide lamps that are installed in an open fixture shall be classified as ANSI Type-O with a shrouded arc-tube or thick-glass parabolic reflector (PAR) for protection.

C. Lamps shall be General Electric, Osram/Sylvania, or Philips Lighting.

D. The Electrical Contractor shall furnish lamps for all fixtures per the schedule on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fixtures as indicated on the Drawings. Verify exact locations from architectural reflected ceiling plans.
    1. Fixtures shall be supported in accordance with Article 410 of the NEC.
    2. All fixture supports shall be capable of supporting the fixture in question plus 100% additional weight.
    3. Fixtures shall not be supported from ductwork or other system components.

B. Provide all mounting hardware, plates, and accessories necessary for a complete installation of all fixtures. Coordinate with various ceiling types.

C. Recessed fixtures in removable ceilings shall be connected to the branch circuit with flexible conduit and branch circuit wire from an accessible junction box. Where fluorescent fixture housings are connected together, use 90°C wire for branch circuit feed through fixture channels.

D. From an accessible approved raceway, outlet or junction box located above a suspended ceiling to recessed or surface lighting fixtures, furnish and install minimum 3/8" flexible metallic conduit at least 4 feet and not more than 6 feet in length. The outlet or junction box shall be located a minimum of 1 foot and not more than 4 feet from the fixture. Minimum size #16 AWG phase and neutral conductors shall be installed in the flexible conduit to the fixture with installation as specified below.

E. Fixtures shall be grounded to the conduit system either through the hanging device or by means of a #14 green jumper. Lamp sockets shall be wired so that the outer shell is connected to the neutral grounded conductor.

F. Fixtures recessed in furred ceiling shall be installed so that they can be removed from below the ceiling.

G. Fixtures installed in plastered or acoustical tile shall not be supported directly from the ceiling. Support fixtures from metal bar hangers or Unistrut channels attached to the ceiling supports.

H. Fixtures installed in lay-in, exposed tee, grid ceilings shall be laid in and provided with hold-down "hurricane" clips (sheet metal screws through the fixture housing are not acceptable, without exception). It is the responsibility of the Electrical Contractor to provide sufficient ceiling hangers to support the weight of the lighting fixtures and associated wiring.

I. Suspended fixtures shall be supported from building structure. Do not use ceiling grid to support suspended fixtures.

J. Cove fixture installations shall be installed to provide an even illumination of the adjacent wall and ceiling. The overall light length shall extend to within two inches of each end of the coved area. The Electrical Contractor shall be responsible for verifying final field measurements and install fixtures accordingly.

K. Where continuous runs of fixtures exist, laser sight to ensure fixtures are installed straight and true. All seams/joints between individual fixtures in the run shall be tightly fitted to avoid light leaks.

END OF SECTION 26 05 01

SECTION 26 06 01-LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Furnish all labor, material and items of service requirements for the completion of a functional and concealed system of grounds, conductors, air terminals, air terminal protector balls and other component parts, for protection against damage by lightning.

1.3 STANDARDS AND CODES

A. The complete installation shall conform to the current requirements of the Underwriters' Laboratories, Inc. UL96A. Upon completion of the work obtain and deliver to the Owner the Underwriters' "Master Label" for attachment to the building at the location indicated.

1.4 DESCRIPTION

A. This Section describes the basic materials and methods of installation for a complete lightning protection system.

1.5 QUALIFICATIONS

A. The materials used in the fabrication of the lightning protection system shall be products of a manufacturer regularly engaged in the manufacturing of the specified material. Where a manufacturer is named for a particular material, the material of other manufacturers will be acceptable provided the material meets requirements of the Specification.

B. The system shall be installed by a qualified Lightning Protection Contractor. The Witchey Lightning Rod Company of Rittman, OH (phone 330-336-6202), or the Western Reserve Lightning Rod Company of Cleveland, OH (phone 216-486-1000).

C. Air terminals and cables at parapet locations shall be mounted on inside face of parapet wall. Fasteners shall not penetrate top cap of parapet.

PART 2 - PRODUCTS

2.1 AIR TERMINALS

A. Air terminals shall be copper and shall conform to the requirements of Chapter 3 of NFPA 780. Air terminals and mounts shall be aluminum for installations where materials will be in direct contact with aluminum roofing or aluminum coping materials.

B. Air terminals installed at non-parapet locations shall include neoprene protective ball accessory.

2.2 CABLES

A. Main and secondary cables shall be copper and shall conform to material requirements outlined in Chapter 3 of NFPA 780. Aluminum cables shall be permitted and installed for installations where cables will be in direct contact with aluminum roofing or aluminum coping materials. Connections between aluminum and copper cables shall be made utilizing compression connectors listed for the purpose.

2.3 GROUND RODS

A. Ground rods shall be not less than 1/2" diameter and 8 feet long. Rods shall be copper-clad steel, solid copper or stainless steel.

2.4 MANUFACTURER

A. Equipment shall be as manufactured by the Independent Protection Company of Goshen Indiana, or the George E. Thompson Co. of Saint Paul, Minnesota.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The entire building shall be protected. All protrusions above the roof, such as chimneys, roof fan housings, air handling units, steel supports, etc. shall also be protected.

B. All conductors shall be installed concealed except for the roof area where exposed runs may be used only at locations that are pre-approved by the Architect.

1. Closely coordinate with the General Trades Contractor and the Electrical Contractor the exact location and installation of all down conductors. Make specific arrangements to provide a fully concealed installation of same.

2. Drive all ground rods to a depth of 6" (minimum) to top of rod below finished grade.

C. Verify roofing material types and coordinate copper/aluminum materials to prevent corrosion due to contact between dissimilar metals.

D. Shop drawings indicating the device accessories, their locations and means of support, routing of conductors and connections of conductors shall be prepared and submitted for approval by the supplier.

END OF SECTION 26 06 01

SECTION 26 09 16-LIGHTING CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Furnish materials, tools, labor, wiring and supervision necessary to furnish and install a complete stand-alone low-voltage lighting control system. Compromised of panels and remote switches as described on the drawings and as specified herein.

1.3 STANDARDS AND CODES

A. Methods of fabrication and installation shall comply with the provisions of applicable Articles of NEC.

B. Materials shall be UL and NEC approved for the application intended.

1.4 DESCRIPTION

A. This Section describes the basic materials and methods of installation for complete low-voltage remote control systems to control lighting and/or other equipment as required by this Section and the Drawings.

B. Systems shall be complete with transformers, relays, switches, wall plates and wiring.

1.5 QUALIFICATIONS

A. System components shall be as manufactured by one of the following:

1. Acuity Brands Lighting Controls (Duffy and Associates, (234) 380-1694)
2. Wattstopper (Lighting Dynamics, (330) 665-9090)
3. Hubbell Controls (Lighting Dynamics, (330) 665-9090)
4. Touche Controls (Myraid Energy (330) 467-0675)
5. Cooper Lighting Solutions (Lighting & Controls, (216) 741-4545)

B. System wiring shown on plans is based on Acuity equipment. It is the Electrical Contractor's responsibility to verify that the wiring shown on the drawings is adequate for the system to be furnished.

1.6 SUBMITTALS

A. Prior to installation of any equipment or raceways, submit shop drawings to Engineer for approval. Submittals shall include:

1. Equipment brochure with annotated cutsheets indicating the equipment being submitted.
2. Device wiring diagrams.
3. Panel schedules including relay type, control type, and quantity of devices.
4. Listing of all materials furnished with the system.

PART 2 - PRODUCTS

2.1 MASTER CONTROLLER

A. The lighting control system master controller shall be:

1. Acuity Controls #NLIGHT-NECY Series.
2. Wattstopper #LMCP Series.
3. Hubbell # NXAC-120 Series.
4. Touche #MSTR-DVLOT-S2 Series.
5. Cooper Lighting Solutions WaveLinx Trellix

B. The lighting control system master controller shall be UL listed and include the following:
1. A surface mounted NEMA 1 enclosure with hinged lockable door.
2. Digital timeclock/programmer capable of controlling the entire lighting control system.
3. Networking capabilities to control all lighting control panels controller devices.
4. Modem for remote factory programming.
5. Photocell input card capable of accepting a minimum of (2) external photocell
a. Acuity Brands #NIO-PC-KIT Series.
b. Wattstopper #LMIO-301 Series.
c. Hubbell #NXDS-0 Series.
d. Touche #MSTR-DVOLT-S2 Series.
e. Cooper Lighting Solutions WaveLinx #UIM Series
6. BAS system interface card with BACNET IP communications capabilities
a. Acuity Brands #NECY w/ BACNET Series.
b. Wattstopper #LMCP Series (Native BACnet).
c. Hubbell #NXAC-120 Series.
d. Touche #MSTR-DVOLT-S2 Series.
e. Cooper Lighting Solutions #MBS-Pro
7. The ability to accept a minimum of (6) dry contact inputs.

2.2 LIGHTING CONTROL RELAY PANELS

A. Lighting control panels shall be:
1. Acuity Controls #ARP Series.
2. Wattstopper #LMCP Series.
3. Hubbell #NXP Series.
4. Touche #RD Series.
5. Cooper Lighting Solutions #WaveLinx IL Area Controller Series

B. The lighting control panels shall be UL listed and include the following:
1. A surface mounted NEMA 1 enclosures with hinged, lockable door.
2. Panel shall contain timeclock/programmer, control relays, transformers, power supplies, relay scanners, photocell, and photocell controller.
3. Panel shall have barriers for separation of the high voltage (Class 1) and low voltage (Class 2).

4. Panels shall be configured to accept a minimum of 8 relays. Refer to drawings for quantity of relays required.
5. Panels shall be capable of being networked together and have the ability to control relays in a network configuration.
6. All programming shall be held in memory on power loss for a minimum of 30 days or panel shall be provide with battery back-up.
7. Relays shall be individual latching relays with 20 Amp load contacts for ballast (including HID, magnetic or electronic type ballasts), tungsten and general purpose loads. Provide isolated auxiliary contacts for pilot light switching, if required. Relays shall use quick connectors and be individually replaceable to facilitate ease of use.
8. Photometric controller shall be digital type with adjustable foot candle levels, adjustable control, of outdoor lighting.
9. Networking capabilities to communicate and be controlled via other lighting control panels and master controller.

2.3 LIGHTING CONTROL DIMMING PANELS

A. Lighting control dimming panels shall be:
1. Acuity Controls #ARP Series.
2. Wattstopper #LMCP Series w/ LMRC 0-10V Control.
3. Hubbell #NXP-DIM8 Series.
4. Touche #RD Series.Cooper Lighting Solutions #WaveLinx IL Area Controller

B. The lighting control panels shall be UL listed and include the following:
1. A surface mounted NEMA 1 enclosures with hinged, lockable door.
2. Panel shall contain timeclock/programmer, control relays, transformers, power supplies, relay scanners.
3. Panel shall have barriers for separation of the high voltage (Class 1) and low voltage (Class 2).
4. Panels shall be configured to accept a minimum of relays per the lighting control panel schedule. Refer to drawings for quantity of relays required.
5. Individual circuit 0-10V dimming capabilities.
6. All programming shall be held in memory on power loss for a minimum of 30 days or panel shall be provide with battery back-up.
7. Relays shall be individual latching relays with 20 Amp load contacts for ballast (including HID, magnetic or electronic type ballasts), tungsten and general purpose loads. Provide isolated auxiliary contacts for pilot light switching, if required. Relays shall use quick connectors and be individually replaceable to facilitate ease of use.
8. Networking capabilities to communicate and be controlled via other lighting control panels and master controller.

2.4 REMOTE CONTROL SWITCHES

A. Scene control switches shall be an individual, momentary push button type. Switches shall be ganged together under a common coverplate as indicated on the drawings. Switches shall be supplied with pilot lights to illuminate when switch is in the "on" position.

B. Metallic coverplates/frames shall be provided for each switch. Color shall be approved by the Architect prior to fabrication.

C. Provide button quantities per the symbol schedule.

D. Scene control station shall be:

1. Acuity Brands #NPODM Series.
2. Wattstopper #LVSW Series.
3. Hubbell #NXSW Series.
4. Touche #WS-TS-C Series.
5. Cooper Lighting Solutions WaveLinx #FDW Series

E. Key switch station shall be:

1. Acuity Brands #NPOD-KEY Series.
2. Wattstopper #LVS-1K w/ LIMIO-101 Series.
3. Hubbell #LUSKEY3MSS Series.
4. Touche #SW-K Series.
5. Cooper Lighting Solutions WaveLinx #GMTL w/ UIM

2.5 Photocell

1. The exterior lighting photocell shall be adjustable from 1-1000 fc.
   a. Acuity Brands #NIO PC KIT Series.
   b. Wattstopper #LMPO-200 Series.
   c. Hubbell #NXDS-0 Series.
   d. Touche #DI-PC Series.
   e. Cooper Lighting Solutions WaveLinx #PPS-5 Series.

2.6 WIRE

A. Low-voltage wiring shall be furnished and installed as described on the Drawings. Wiring shall be provided for a complete system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panels, relays, remote-control switches, and interconnecting wiring as indicated on the Drawings and as required for a complete system.

B. All wiring shall be installed in conduit. Refer to Section 26 01 11- Conduit Systems.

C. All terminations shall be as per the manufacturer's approved shop drawing and recommendations.

D. The Electrical Contractor shall be responsible for programming the system and device settings for proper system operations. Final program schedule shall be reviewed with Owner.

E. All programming required for proper system operation and as required by the Architect, Engineer, and Owner shall be the responsibility of the Electrical Contractor.

F. Tutorial of the system operation and programming shall be provided by the Manufacturer’s Representative for the Maintenance Staff.

3.2 TESTING

A. Upon completion, the Contractor shall conduct a total system test for the Owner, and Engineer. At minimum, this test shall include:

1. Operating all control devices.

2. Verifying operation of zone controls.

END OF SECTION 26 09 16

SECTION 26 09 32-AUTOMATIC LIGHTING CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

1.2 SCOPE

A. Provide material, equipment, labor, and supervision as required for the complete installation of lighting controls as required by the Drawings and this Specification.

B. The objective of this section is to ensure the proper installation of the occupancy sensor based lighting control system so that lighting is turned off automatically after reasonable time delay when a room or area is vacated by the last person to occupy said room or area.

C. It shall be the contractor's responsibility to make all proper adjustments to assure Owner's satisfaction with the occupancy system.

1.3 CODES AND STANDARDS

A. Lighting controls and relays shall be UL 508 listed and marked.

B. UL-924 Standard for Emergency Lighting and Power Equipment

C. Applicable local energy codes.

D. NFPA 70

1.4 QUALIFICATIONS

A. Line voltage occupancy sensors shall be as manufactured Hubbell, Leviton, Philips, Sensor Switch, Wattstopper, or Cooper.

B. Low voltage controls system wiring shown on plans is based on Acuity Nlight equipment. It is the Electrical Contractor's responsibility to verify that the wiring shown in the drawings is adequate for the system to be furnished. Any additional cabling, conduit, equipment, or devices required for a complete installation shall be provided as part of the base bid.

1.5 SUBMITTALS

A. Submittal data shall consist of shop drawings incorporating required technical data and dimensions.

PART 2 - PRODUCTS

2.1 GENERAL

A. Contactors, relays and time switches shall be as described on drawings.

2.2 WALL SWITCH LINE VOLTAGE OCCUPANCY SENSORS

A. Single wall switch with integral passive infrared sensor (PIR) technology shall be universal line voltage type with adaptive learning technology and 1,000 square foot, 180 degree coverage.

1. Hubbell #LHIRS1 Series.
2. Leviton #ODS15-ID Series.
3. Philips #LRS2210 Series.
4. Sensor Switch #WSX Series.
5. Wattstopper #PW-100 Series.

6. Cooper #OSW-P-1001-MV Series.

B. Single wall switch with integral passive infrared sensor (PIR) technology and LED nightlight shall be 120 or 277 volt type, as required per Drawings, with 1,000 square foot, 180 degree coverage.

1. Hubbell #LHN-IRS Series.
2. Leviton #OSSNL-ID Series.
3. Philips #LRS2230 Series.
4. Sensor Switch #WSX-NL Series.
5. Wattstopper #PW-103N Series.
6. Cooper #VNL-W-P-1001-MV Series.

C. Dual wall switch with integral passive infrared sensor (PIR) technology and LED nightlight shall be 120 or 277 volt type, as required per Drawings, with 1,000 square foot, 180 degree coverage.

1. Hubbell not available (2) single wall switches acceptable.
2. Leviton not available (2) single wall switches acceptable.
3. Philips not available (2) single wall switches acceptable.
4. Sensor Switch #WSX-2P-NL Series.
5. Wattstopper #CS-350-N Series.
6. Cooper not available (2) single wall switches acceptable.

D. Single wall switch with integral dual technology sensor (PIR and ultrasonic) shall be universal line voltage type with adaptive learning technology and 1,000 square foot, 180 degree coverage.

1. Hubbell #LHMTS1 Series.
2. Leviton #OSSMT-MD Series.
3. Philips #LRS2220 Series.
4. Sensor Switch #WSX-PDT Series.
5. Wattstopper #DW-100 Series.
6. Cooper #ONW-D-1001-MV Series.

E. Dual wall switch with integral dual technology sensor (PIR and ultrasonic) shall be universal line voltage type with adaptive learning technology and 1,000 square foot, 180 degree coverage.

1. Hubbell #LHMTD2 Series.
2. Leviton #OSSMD-MT Series.
3. Philips #LRS2225 Series.
4. Sensor Switch #WSX-PDT-2P Series.
5. Wattstopper #DW-200 Series.
6. Cooper #ONW-D-1001_DMV Series.

F. Single wall switch with integral passive infrared sensor (PIR) technology with 0-10V dimming capabilities shall be universal line voltage type with adaptive learning technology and 1,000 square foot, 180 degree coverage.

1. Hubbell #LHDM-IRS Series.

2. Leviton #ODD10-ID Series.
3. Philips (not available).
4. Sensor Switch #WSX-D Series.
5. Wattstopper #PW-311 Series.
6. Cooper #OSW-P-010 Series.

G. Single wall switch with integral dual technology sensor (PIR and ultrasonic) with 0-10V dimming capabilities shall be universal line voltage type with adaptive learning technology and 1,000 square foot, 180 degree coverage.

1. Hubbell #LHDM-MTS Series.
2. Leviton (not available).
3. Philips (not available).
4. Sensor Switch #WSX-PDT-D Series.
5. Wattstopper #DW-311 Series.
6. Cooper #OSW-D-010 Series.

2.3 CORNER MOUNTED LINE VOLTAGE OCCUPANCY SENSORS

A. Wall and ceiling mounted passive infrared sensors (PIR only) technology sensors shall be low voltage type with adaptive learning technology, 1200 square foot, 120 degree coverage, isolated relay for use by BAS system and integral light level sensor.

1. Hubbell #LOIRWVRP Series.
2. Leviton #OSWWV-IOW Series.
3. Philips #LRM2270 Series.
4. Sensor Switch #WV-16-R-P Series.
5. Wattstopper #CX-100 Series.
6. Cooper #OAWC-P120W-R Series.

2.4 CEILING MOUNTED LINE VOLTAGE OCCUPANCY SENSORS

A. Ceiling mounted passive infrared sensors (PIR only) technology sensors shall be low voltage type with adaptive learning technology, 360 degree coverage area of 1000 square feet minimum, isolated relay for use by BAS system and integral light level sensor.

1. Hubbell #OMNIIRP Series.
2. Leviton #OSC15-IOW Series.
3. Philips #LRM2250 Series.
4. Sensor Switch #CM-10-R-P Series.
5. Wattstopper #CI-300 Series.
6. Cooper #OAC-P-1500-R Series.

B. Ceiling mounted dual technology sensors (PIR and ultrasonic) shall be low voltage type with adaptive learning technology, 360 degree coverage area of 1000 square feet minimum, isolated relay for use by BAS system, and integral light level sensor.

1. Hubbell #OMNIDTRP Series.
2. Leviton #OSC10-M.

3. Philips #LRM2255 Series.
4. Sensor Switch #CM-PDT-9-R-P Series.
5. Wattstopper #DT-300 Series.
6. Cooper #OAC-DT-1000-R Series.

2.5 DAYLIGHT SENSORS

A. Ceiling mounted daylight sensors with automatic on/off switching, adjustable foot-candle set point, adjustable dead-band set point, and white finish.

1. Hubbell (not available).
2. Leviton #PCC1S Series.
3. Philips #LRL2380 Series.
4. Sensor Switch #CM-PC Series.
5. Wattstopper #LS-102 Series.
6. Cooper #DLC-PD-DIM Series.

B. Ceiling mounted daylight sensor with automatic 0-10V dimming capabilities, adjustable foot-candle set point, and white finish.

1. Hubbell #DLC7 Series.
2. Leviton #ODC0P-D0W Series.
3. Philips #LRL1222 Series.
4. Sensor Switch #CM-ADC Series.
5. Wattstopper #LS-301 Series.
6. Cooper #DLC-PD-DIM Series.

2.6 DIGITAL TIME SWITCH

A. Wall mounted digital time switches shall be universal 120/277V type with on/off push button, adjustable digital timer, visual flash warning and capable of three way control.

1. Hubbell #TD300 Series.
2. Leviton (not available).
3. Philips #LTA24550C Series.
4. Sensor Switch #PTS Series.
5. Wattstopper #TS-400 Series.
6. Cooper #TSW-MV Series.

2.7 ACCESSORIES

A. Relay/power packs shall be furnished with universal 120/277V input, 24 VDC output, and 20 amp, 277 volt switching contact.

1. Hubbell #UVPP Series.
2. Leviton #002-OSP20-RD0 Series.
3. Philips #LCA Series.
4. Sensor Switch #PP20 Series.

5. Wattstopper #BZ-50 Series.
6. Cooper #SP20-MV Series.

B. Slave power packs (relay only) shall be furnished with 24 VDC coil input and 5 amp, 277 volt switching contact.

1. Hubbell #RRU Series.
2. Leviton #OSA20 Series.
3. Philips #LCA Series.
4. Sensor Switch #SP20 Series.
5. Wattstopper #A277C-P Series.
6. Cooper #SP20-MV Series.

2.8 LOW VOLTAGE LIGHTING CONTROL SYSTEMS

A. Wall mounted low voltage 2-button (on, off controls) lighting control station with low voltage networking capabilities.

1. Acuity NLight #NPODM Series.
2. Hubbell #NXSW-OO Series.
3. Wattstopper #LMSW-101 Series.
4. Cooper #RC-2TLB Series.

B. Wall mounted two zone low voltage 4-button (on/off controls) with low voltage networking capabilities.

1. Acuity NLight #NPODM-2P Series.
2. Hubbell #NXSW-4 Series.
3. Wattstopper #LMSW-104 Series.
4. Cooper #RC-4TSB Series.

C. Wall mounted low voltgate 3-button (on/off, raise, lower control) with low voltage networking capabilities.

1. Acuity Nlight #NPODM-DX Series.
2. Hubbell #NXSW-ORLO Series.
3. Wattstopper #LMSW-103 Series.
4. Cooper #RC-3TLB Series.

D. Wall mounted touchscreen room control with scene controls, individual zone controls, pin code lockout with low voltage networking capabilities.

1. Acuity NLight #NPOD-GFX Series.
2. Hubbell #NXSW-TH3 Series.
3. Wattstopper #EQ40TB Series.
4. Cooper #TSE55-B Series. (Power over ethernet – provide separate PoE network switch).

E. Surface ceiling mounted dual technology (PIR/microphonics) occupancy sensor with 360 degree coverage of 1000 square feet minimum, light sensor, isolated relay for use by BAS, and low voltage networking capabilities.

1. Acuity NLight #NCM-PDT-10 Series.
2. Hubbell #NXOS-OM-DT-1-R Series.
3. Wattstopper #LMDC-100-LMRL-100 Series.
4. Cooper #OAC-DT-1000-R/OCC-RJ45 Series.

F. Wall and ceiling mounted dual technology (PIR/microphonics) occupancy sensor with 120 degree coverage of 70 feet, mounting bracket, and low voltage networking capabilities.

1. Acuity NLight #NWV-PDT-16 Series.
2. Hubbell #OS-LODT-R Series.
3. Wattstopper #LMDX-100 Series.
4. Cooper #OAWC-DT-120W-R/OCC-RJ45 Series.

G. Surface ceiling mounted single zone daylight harvesting photocell sensor with dimming controls, adjustable setting pushbuttons, and low voltage networking capabilities.

1. Acuity NLight #NCM-ADCX Series.
2. Hubbell #NXDS Series.
3. Wattstopper #LMLS-400 Series.
4. Cooper #DSRC-FMOIR Series.

H. Relay power pack with 16A relay, 120/277V universal input, and low voltage networking capabilities.

1. Acuity NLight #NPP16 Series.
2. Hubbell # NXRC-1R-UNV Series.
3. Wattstopper #LMRC-100 Series.
4. Cooper #RC3-PL Series.

I. Dimming relay power pack with 16A relay, 120/277V universal input, 0-10V dimming, and low voltage networking capabilities.

1. Acuity NLight #NPP16-D Series.
2. Hubbell # NXRC-1RD-UNV Series.
3. Wattstopper #LMRC-211 Series.
4. Cooper #RC3D-PL Series.

J. Emergency transfer dimming relay power pack with 16A relay, 120/277V universal input, 0-10V dimming, UL924 emergency operation, unswitched voltage sensing terminal, and low voltage networking capabilities.

1. Acuity NLight #NPP16-D-ER Series.
2. Hubbell # NXRC-1RD-UNV-UL924EPC1-D Series.
3. Wattstopper #LMRC-211-ELCU-200 Series.
4. Cooper #RC3DE-PL Series.

K. Standalone BAS interface relay power pack with low voltage relay and low voltage networking capabilities.

1. Acuity NLight #NAR40 Series.

2. Hubbell #NXCI Series.
3. Wattstopper #LMRL Series.
4. Cooper #OCC-RJ45 Series.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install switching devices, low voltage controls, and interconnecting wiring as indicated on the Drawings and as required for complete system operation.

B. All terminations shall be as per the manufacturer's approved shop drawing and recommendations.

C. Provide all required mounting accessories.

D. Make all power and control connections.

E. The electrical contractor shall be responsible for programming the system and device settings for proper system operations.

F. All programming required for proper system operation and as required by the Architect, Engineer, and Owner shall be the responsibility of the Electrical Contractor.

G. Two hour (min) tutorial of the system operation and programming shall be provided by the manufacturer for the Maintenance Staff.

H. Program graphic stations as directed by the Owner.

I. Make final sensor adjustments after sensor installation for optimal performance.

1. Daylight sensors in corridors shall be set for 15 FC with 50% dead band and 10 minute off delay, unless noted otherwise.
2. Occupancy sensors shall be set for a 20 minute auto-off manual-on operation where applicable.
3. Occupancy sensors with integral light sensors shall be set for 15 FC (150 Lux), unless noted otherwise.

J. It shall be the contractor’s responsibility to locate and aim sensors in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer’s recommendations. Locate sensor at the minimum distance from HVAC diffusers as directed by the manufacturer. Rooms shall have ninety (90) to one hundred (100) percent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The Electrical Contractor shall locate sensors to properly and completely cover the respective room.

K. Proper judgment must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components.

L. Upon completion of the installation, the system shall be completely commissioned by the Electrical Contractor, who will verify all adjustment and sensor placement to ensure a trouble-free occupancy-based lighting control system.

END OF SECTION 26 09 32

SECTION 26 09 50-ELECTRICAL BID ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Furnish materials, labor and supervision necessary for the bid alternates as described.

B. Refer to Contractor's Bid Form for further details of bid alternates.

1.3 DESCRIPTION

A. Alternate #G1: State the amount to be added to the Base Bid for all labor and materials associated with the installation of the Greenhouse.

B. Alternate #G2: State the amount to be added to the Base Bid for all labor and materials associated with the development of the existing open classroom space within the existing building at the north end of the new Sky Bridge.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION 26 09 50

SECTION 27 00 51-BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Related and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. The following Division 26 sections also apply to the work of this Division:

1. 26 00 52 - Tests
2. 26 00 53 - General Wiring
3. 26 00 54 - Cutting and Patching
4. 26 00 55 - Temporary Power
5. 26 00 56 - Firestopping
6. 26 00 60 - Excavating, Trenching, Backfilling and Restoration
7. 26 00 74 - Electrical Demolition and Salvage
8. 26 01 11 - Conduit Systems
9. 26 01 14 - Cable Tray
10. 26 01 20 - Wire and Cable
11. 26 01 25 - Pulling Cables
12. 26 01 40 - Wiring Devices and Plates
13. 26 01 52 - Wiring of Equipment Furnished Under Other Divisions
14. 26 04 50 - Grounding

1.2 SCOPE

A. The work shall include the furnishing of systems, equipment and materials specified in this Division and as called for on the Drawings, to include: supervision, operations, methods and labor for the fabrication, installation, start-up and tests for the complete electrical installation.

B. Drawings for the work are diagrammatic, intended to convey the scope of the work and to indicate the general arrangement and locations of the work. Because of the scale of the Drawings, certain basic items such as conduit fittings, access panels, sleeves, pull and junction boxes may not be shown. Where such items are required by Code or by other Sections, or where they are required for proper installation of the work, such items shall be included.

C. Equipment Specification may not deal individually with minute items such as components, parts, controls and devices which may be required to produce the equipment performance specified or as required to meet the equipment warranties. Where such items are required, they shall be included by the supplier of the equipment, whether or not specifically called for.

1.3 ELECTRICAL REFERENCE SYMBOLS

A. Symbols used on the floor plans are defined in the Electrical Symbols Schedule on the Drawings. Not necessarily will all symbols scheduled be required for the project.

B. The symbols used for schematic or one line power and control wiring diagrams are American Standard Graphical Electrical Symbols and are published in American Standard Chart Z32.3.

1.4 PERMITS, INSPECTIONS AND CODES

A. The Contractor shall secure and pay for all permits and inspections required by the governing authorities for the prosecution of the electrical work of this division. All permits and certificates of inspection and approval signed by the controlling building department shall become the property of the Owner.

B. All wiring shall be in compliance with the current edition of the National Electric Code, applicable State and City regulations and OSHA. In cases of conflict between Code and Specifications, the more restrictive requirements shall govern.

1.5 VISIT TO THE SITE

A. The Electrical Contractor shall be required to visit the site of the work and familiarize himself with all such conditions affecting the work. The submission of his bid proposal shall presuppose his knowledge of all such conditions.

1.6 WORKMANSHIP

A. Employ only experienced craftsmen under direct supervision of a full time competent foreman.

B. Keep fully informed as to progress of work, so that work of this Division may be built into place in sufficient time to insure against delay to other trades, and to prevent misalignments or damage to electrical work.

1.7 COORDINATION, CONDUCT AND SCHEDULING OF WORK

A. Electrical drawings are diagrammatic, indicating general arrangement, approximate sizes, general locations of equipment and outlets. Verify dimensions in field; adjust to manufacturer's shop drawings. Do not scale drawings.

B. Architectural and structural drawings supersede electrical drawings. Determine that work of this Division can be accommodated within spaces provided. Notify Construction Manager and/or Architect of any interferences before starting installation.

C. Determine sizes, locations for chases, openings necessary for installation of electrical work; cooperate with other trades in setting of sleeves, inserts and hangers.

D. Coordinate this work with all trades, serving utilities and equipment suppliers. Arrange operation, submittal approvals and equipment delivery, so as not to delay installation or completion of any parts of interrelated work so that construction may proceed on schedule.

E. Cooperate with Mechanical trades in preparing interference drawings for points where there is possible conflict between trades. Exact locations of pipes, ducts, conduit based on field measurements with final arrangement to be determined by intra-trade agreements subject to Construction Manager's and/or Architect's review.

F. Architect reserves the right to make reasonable changes in indicated locations without extra cost to the Owner.

G. Drawings other than electrical drawings, and other sections of this Specification, may show or specify electrically operated equipment, wiring diagrams, etc. The Contractor shall examine all such drawings and specification sections and become familiar with the characteristics and required connections for all equipment.

H. Conduits, wiring and equipment shall be arranged substantially as indicated. Any change resulting in a savings in labor or material shall be made only in accordance with a contract change order. Deviations shall be made only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted to and approved by the Architect.

1.8 MATERIALS

A. All equipment and devices shall be new and shall conform to NEMA and Underwriters' Laboratories Standards. Where Specifications describe, or plans show, materials or equipment of higher quality than required by code and local ruling, the Drawings and Specifications shall govern the quality of the material or equipment.

B. Materials and equipment used as extensions to existing special systems shall be of matching electrical characteristics for satisfactory operation of the complete system and shall be of the same manufacture and design unless otherwise approved.

C. The Contractor shall submit proof, if requested by the Architect, that the materials, appliances, equipment or devices that he furnishes and installs under this contract, meet the requirements of the Underwriters' Laboratories, Inc. and its publications will be referred to hereinafter by the abbreviation UL, with or without additional identifying symbols.

D. The National Electrical Code (NEC) of the National Fire Protection Association, and Publications and Standards of the organizations listed below are referenced herein by the abbreviations noted in parentheses, with or without additional identifying symbols. Unless otherwise specified, all work shall be manufactured, tested and installed in accordance with such reference standards.

1. American Society for Testing and Materials (ASTM)
2. Underwriters' Laboratories, Inc. (UL)
3. Insulated Power Cable Engineers Association (IPCEA)
4. National Electrical Manufacturers Association (NEMA)
5. Institute of Electrical and Electronic Engineers (IEEE)
6. American National Standards Institute, Inc. (ANSI)
7. National Fire Protection Association (NFPA)

1.9 GUARANTEE

A. The Electrical Contractor shall guarantee for a period of one year that all work and equipment will remain free from all defects in workmanship and materials, and that it will comply with all the specific requirements of the Specifications and other Contract Documents governing the work.

B. All work found by the Architect to be defective will be replaced with new work meeting all the requirements of the Contract. The Electrical Contractor will bear all costs of supplying such new work, and installing and finishing same, and will assume all costs for replacing other work damaged by the removal and replacement of any of the work. The Electrical Contractor will bear all costs for freight, drayage and demurrage, and all labor in connection therewith.

1.10 SUBMITTALS

A. This Contractor shall prepare or obtain from the manufacturer certified shop or erection drawings of the items listed below. After Contractor’s review and approval of the proposed submittal, electronic copies of each shall be stamped and submitted to the Architect for approval before proceeding with installation or construction.

B. Approval drawings shall be submitted for the following items. Acceptable manufacturers shall be as described in the individual specification sections except where specifically noted below:

1. 27 07 40 - Communication Cabling and Equipment
2. 27 07 70 - Paging System
3. 27 07 71 - Classroom Sound System

4. 27 07 81 - CATV System
5. 27 07 82 - Audio/Visual Systems

C. Electronic submittals shall conform to the following requirements:

1. Electronic submittals shall be in Portable Document Format (.pdf)
   a. Electronic submittals shall include a transmittal.
   b. All portions of the electronic submittal shall be bound in a single .pdf file.
   c. All content of the submittal shall be visible/readable and shall clearly indicate each item to be reviewed. Indicate specific options or accessories on shop drawings by pointing to, checking off, underlining, or other means.
   d. File shall be named to match submittal contents.
   e. Submittals shall include a specific notice of any deviation from the Contract Documents.
2. Electronic submittals shall include a Contractor review stamp that indicates review and approval by the Contractor prior to submission.
3. Electronic submittals shall be transmitted via an email.
   a. One submittal per email.
   b. Email shall clearly contain, project name and contents of submittal.
4. Failure to conform to the requirements above may result in rejection.
5. The Reviewer shall return the submittals in a format and method appropriate for the Project and the response.

D. AutoCAD floor plans are available to Vendors and Contractors to assist in generation of shop drawings.

E. Prior to the signing of the contract the successful bidder shall submit to the Architect a list of manufacturers of the major items of equipment he proposes to furnish and the names of any subcontractors he proposes to employ.

1.11 ENGINEER'S REVIEW

A. Shop drawings shall be reviewed for general compliance. The Reviewer will make reasonable efforts to detect and correct errors, omissions and inaccuracies but shall not be responsible for failure to detect errors, omissions, or inaccuracies. Failure to detect errors, omissions and inaccuracies shall not relieve the Contractor of responsibility for the proper and complete installation in accordance with the intent of the Contract Documents.

B. The Engineer shall mark the shop drawings in one of the ways outlined below. See each description for interpretation of Engineers marks and Contractor responsibilities associated with each.

1. APPROVED: The submittal complies with the requirements of the specifications.
2. APPROVED AS NOTED: The submittal generally complies with the requirements of the specifications but some non-critical items which need to be corrected/coordinated are noted. The corrections shall be changed on the shop drawings submitted for inclusion in the Operations and Maintenance Manual. Re-submittal is not required unless noted otherwise.
3. REVISE AND RESUBMIT: The submittal generally complies with the requirements of the specifications but some critical items which need to be corrected/coordinated are noted. The submittal must be revised and resubmitted with all comments addressed.

4. REJECTED: The submittal does not comply with the requirements of the specifications. The submittal must be revised and resubmitted.

C. Approval of submittal items shall not eliminate the Engineers right to reject those items if defects are discovered prior to final acceptance of the completed work.

1.12 SUBSTITUTION

A. Bidders desiring to make a substitution for the specified brand or method shall list such proposed substitution. In each case state the difference in price where substitution is offered. If there is no difference in price, so state.

B. It shall be understood that the proposal submitted shall be based on the different branches of work and materials specified, and that the Owner is entitled to the use of the materials so specified. Substitution sheet shall be signed and dated by the Electrical Contractor and shall be formatted as follows:

BRAND OR MAKE SPECIFIED	PROPOSED SUBSTITUTION	ADD	DEDUCT

1.13 CONCRETE WORK

A. Concrete bases and pads for electrical equipment identified on the Drawings or as required shall be the responsibility of this Section.

B. Pads shall be 3" high with chamfered top edges unless otherwise noted on the Drawings. Pad sizes and locations shall be determined by the Electrical Contractor (do not scale from the Drawings).

C. This Contractor shall furnish all equipment anchor bolts and shall be responsible for their proper installation and accurate location.

1.14 NAMEPLATES AND LABELS

A. The Electrical Contractor shall furnish and install a system of nameplates designed to identify each piece of equipment, control unit thereon, and major distribution points. The following color scheme shall be used as a guide:

1. For switchboards, panelboards, control centers, all panels and remote control and indicating devices served by "normal" power, use black plastic, laminated, with white engraved letters to identify basic unit name and system, and each sub-system name and use. For equipment served by "emergency" power, use red plastic, laminated, with white engraved letters.

2. For fire alarm system cabinet and panels, use red laminated plastic with white engraved letters.

3. For telephone distribution cabinets and panels, use black plastic with white engraved letters.

4. Size of nameplates shall be made to readily differentiate between, and identify, equipment and usage. Nameplate identifying items that are transferred to emergency power shall carry a nameplate saying "EMERGENCY".

5. Exposed feeder conduits shall be identified as to load fed and voltage (Normal or Emergency) with 1" high black stenciled letters and numerals; conduit shall be marked every 50 feet. This shall include existing spare conduits.

B. Fasten nameplates to all enclosures by use of stainless steel sheet metal screws.

C. A label reading "contains emergency circuits" shall be installed on all boxes and enclosures that contain emergency powered circuits to comply with NEC 700.9(A).

1. Labels shall be installed on front covers of all pull boxes, junction boxes and control enclosures.
2. Labels shall be installed on interior trim of all branch circuit panelboards.
3. Labels shall be installed on front trim of each transfer switch.

D. The Electrical Contractor shall furnish and install Arc Flash Warning labels in a clearly visible location on the front trim of all switchboards, panelboards (inside the hinged panel cover), industrial control panels and motor control centers to comply with NEC 110.16. Labels shall be Brady Identification Solutions (1-800-537-8791) cat. no. 94913, 3.5" x 5", or equivalent.

1.15 CLEANING AND PAINTING

A. Touch up and repair any damaged factory finishes on equipment and materials furnished. Other painting will be done under the Painting Division of the Specifications.

B. Remove any rust spots and prime with rust inhibitive paint any metal surfaces of electrical devices not provided with rust inhibitive coatings. Then apply one coat of paint in color as directed by Architect.

C. Swab interiors of conduits clean and dry before pulling wire. Clean interiors of boxes and cabinets before installing trims and covers.

1.16 TESTS

A. Systems shall be tested by the Electrical Contractor and placed in proper working order prior to demonstrating systems to Owner.

B. Perform such tests as required by authorities having jurisdiction over the site.

C. Perform tests as described in all subsequent sections of this Division and Related Documents.

1.17 DEMONSTRATIONS

A. Prior to acceptance of the work, the Contractor shall demonstrate to the Owner or his designated representative all features and functions of all systems and shall instruct the Owner in the proper operation of the systems. Each system shall be demonstrated once.

B. The demonstrations shall consist of not less than the following:

1. Point out the actual location of each component of a system and demonstrate its function and its relationship to other components within the system.
2. Demonstrate the electrical systems by actual "start-stop" operation showing how to work controls, how to reset protective devices, how to replace fuses, and what to do in an emergency.
3. Demonstrate communication, signal, alarm and detection systems by actual operation of the systems and show how to reset signal, alarm and detection devices.

C. Systems to be demonstrated shall include but not be limited to the following:

1. Alarm Detection and Signal Systems
2. Communication Systems
3. Paging System
4. Classroom Sound System
5. Audio Visual Systems

D. Contractor shall furnish the necessary trained personnel to perform the demonstrations and instruction, and shall arrange to have the manufacturer's representatives present to assist with the demonstrations.

E. Contractor shall coordinate dates and times for performing all demonstrations with the Owner.

1.18 OPERATION AND MAINTENANCE MANUALS

A. Electrical Contractor shall furnish to the Owner operation/maintenance manuals as described in the Division 1 Specifications.

B. Manuals shall meet or exceed all Division 1 Specification requirements and shall minimally include three (3) individually bound and indexed (thumb tabbed) manuals. Each manual shall provide operating instructions, maintenance manuals, spare parts listing, copies of warranties, wiring diagrams, inspection procedures and shop drawings on all equipment and systems.

C. Unless otherwise directed by the Division 1 Specification each manual shall be bound in a heavy-duty, 3 inch, three-ring vinyl covered binder with pocket folders for drawings and folded sheet information. Each binder shall be identified on both the front and the spine.

1.19 AS-BUILT DRAWINGS

A. As work progresses during the construction period, the Electrical Contractor shall record (on a dedicated set of bid drawings) any deviations from the design drawings. The completed record set of as-built drawings shall be delivered to the Architect prior to the Electrical Contractor's request for final payment.

B. As-built documentation shall meet or exceed all Division 1 Specification requirements.

1.20 PROJECT CLOSE-OUT

A. The installing Contractor shall contact the Engineers' office upon completion of the installation to request final inspection. At that time the following documents shall be assembled and provided for review at the job site:

- ☐ Photocopies of all signed electrical inspection permits.
- ☐ O & M Manuals (as described above).
- ☐ Photocopies of certified test results, as required by all specification sections.
- ☐ "As-Built" print set.
- ☐ Photocopy of Printout from Alarm Systems listing device addresses and custom labels.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION 27 00 51

SECTION 27 07 40-COMMUNICATION CABLING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Provide material, equipment, labor, testing, and supervision as required for an extension of the existing telephone, data, and central monitor communications systems as specified herein and described on the Drawings.

B. This Section shall provide devices, outlets, cable, testing, labor and miscellaneous items described on the Drawings.

1.3 STANDARDS AND CODES

A. The communications system installation furnished under this specification shall comply with the applicable provisions of the following standards and codes:

1. NFPA 70, National Electrical Code Article 770
2. NFPA 70, National Electrical Code Article 800
3. EIA/TIA Standards
4. BICSI Standards
5. National Institute of Standards and Technology (NIST) Calibrated Test Equipment
6. State Codes
7. Local Codes and Ordinances

1.4 GUARANTEE

A. This Contractor must have five years minimum experience in data network wiring installations. This Contractor shall be a certified installer for the structured cabling solution utilized and shall provide a minimum fifteen (15) year extended Product and Applications Assurance warranty on parts and labor from the connectivity system manufacturer (certified contractor program). Contractor shall be a certified installer for the manufacturer utilized.

B. All work/equipment found to be defective will be replaced with new work/equipment meeting all the requirements of the Contract. The Electrical Contractor will bear all costs of supplying such new work, and installing and finishing same, and will assume all costs for replacing other work damaged by the removal and replacement of any of the work.

1.5 QUALIFICATIONS

A. Equipment racks and accessories shall be as manufactured by one of the following.

1. Great Lakes
2. Middle Atlantic
3. Chatsworth
4. Homaco
5. Commscope
6. Leviton
7. Legrand

8. Siemon

B. Patch panels and work station outlets shall be as manufactured by the following. Specifications are based on Leviton.

1. Leviton
2. Legrand
3. Siemon

1.6 SUBMITTALS

A. Prior to purchase of any equipment or cables, submit shop drawings to Engineer for approval. Submittals shall include:

1. Equipment brochure with specification sheets.
2. Device wiring diagrams with required color coding noted.
3. Listing of all materials furnished with the system.

B. AutoCAD floor plans are available to Vendors and Contractors to assist in generation of shop drawings. A nominal fee will be charged to prepare the plans for processing and email delivery of files. Refer to Division 1 Specifications for additional information.

PART 2 - PRODUCTS

2.1 EQUIPMENT RACKS

A. Equipment rack shall be furnished, set and assembled by the Electrical Contractor.

B. Racks shall be cabinet type with integral 4-post rack, complete with anchoring hardware, and shall be anchored to the floor by the Electrical Contractor.

C. Floor mounted equipment racks shall be Great Lakes #ES series or equal with the following features:

1. Outside dimensions shall be 24" wide x 84" high x 48" deep.
2. Internal dimension shall be with 44 unit spaces with 46" usable depth.
3. Construction shall be welded steel with black powder coat finish, designed to support up to 2500 pounds of equipment.
4. Rack rails shall have threaded #12-24 mounting holes with EIA-310-D standard mounting hole pattern (front and rear).
5. 12" wide external side mounted vertical wiring manager with black doors, quantity as required to install one between gang mounted racks and at each rack end. Great Lakes #ES-Sidecar series.
6. Black mesh doors at front and rear of cabinet.
7. Integral top plate for connection to cable ladder tray.

D. Racks shall be floor mounted using appropriate seismic mounting hardware.

E. Racks shall be furnished with vertical 24 outlet (22 NEMA 5-15 and 2 NEMA 5-20) power strip with integral circuit breaker and ten foot NEMA 5-20 cord and plug. Middle Atlantic # PD-2420SC-NS or equal.

F. Racks shall be provided with a micarta engraved nameplate to indicate its rack designation (IDF-XX).

2.2 WIRE MANAGEMENT BRACKETS

A. Wire Management Brackets shall be 19" rack mountable, furnished and installed by Electrical Contractor.

B. Horizontal Wire Management Brackets shall be Chatsworth #Evolution-35442-702 series, or equal.

2.3 FIBEROPTIC PATCH PANELS

A. Fiberoptic Patch Panels shall be Leviton #5R2UM-F06 series with the following features:

1. Two RU enclosure with front and rear removable tray, locking doors, cable management and capacity for 24 LC ports.

2. Panels shall be furnished with 19" rack mounting brackets/hardware and slide mount kit.

B. Provided modular mounting plates with LC singlemode (OS2) blue adapters with ceramic alignment sleeves. Leviton #5F100-2LL or equal.

1. Provide blank plates for unused adapter panel openings.

C. Patch Panels shall be labeled per Part 3 of these specifications

2.4 FIBER SPLICE BOX

A. Fiberoptic wall mounted splice boxes shall be Leviton #5WSML-02C series with the following features:

1. Locking doors, cable management and capacity for 48 strands.

2. Adapter plates with capacity for 12 LC ports.

B. Labeled per Part 3 of these specifications

2.5 ANALOG TELEPHONE 110 WIRING BLOCKS

A. Wall mounted Telephone 110 wiring blocks shall be Leviton #41AW2-100 series, or equal, with the following features:

1. 110 Style, CAT 5E rated with 100-Pair capacity.

2. 5 pair connecting blocks.

3. Standoff bracket/hardware.

4. Blocks shall accept #22 thru #26 AWG solid copper conductors.

5. Labels and clear label holders.

B. Blocks shall be labeled per Part 3 of these specifications.

2.6 ANALOG TELEPHONE 66 WIRING BLOCKS

A. Wall mounted Telephone Punchdown Blocks shall be Leviton #4066-M50 series, or equal, with the following features:

1. 66 Style, with 50-Pair capacity (50-Pair In, 50-Pair Out).

2. Blocks shall be furnished with standoff bracket/hardware.

3. Blocks shall accept #22 thru #26 AWG solid copper conductors.

4. Blocks shall be furnished with wire distribution spools, quantity as necessary for performing cross connects between punch blocks.

B. Blocks shall be labeled per Part 3 of these specifications.

2.7 DATA/VOIP PATCH PANELS

A. Patch Panels shall be 19" rack mountable.

B. Patch Panels shall be modular assemblies with (48) RJ45 Category 6 UTP rated T568B female jacks.

1. Each port shall be provided with an adhesive label with the associated cable identification number permanently identified in black lettering.

2. Provide jacks to match cable jacket color.

C. Cabling shall be terminated in rear (back) of patch panels with 110 type terminations. Panels shall contain rear wire management.

D. Workstation Data Patch Panels shall be Leviton #69270 series or equal.

E. Patch Panels shall be labeled per Part 3 of these specifications.

2.8 CENTRAL MONITOR PATCH PANELS

A. Patch Panels shall be 19" rack mountable.

B. Patch Panels shall be modular assemblies with (48) RJ45 Category 6 UTP T568B female jacks.

1. Each port shall be provided with an adhesive label with the associated cable identification number permanently identified in black lettering.

2. Provide jacks to match cable jacket color.

C. Cabling shall be terminated in rear (back) of patch panels with 110 type terminations. Panels shall contain rear wire management.

D. Workstation Data Patch Panels shall be Leviton #69270 series or equal.

E. Patch Panels shall be labeled per Part 3 of these specifications.

2.9 SECURITY CAMERA PATCH PANELS

A. Patch Panels shall be 19" rack mountable.

B. Patch Panels shall be modular assemblies with (48) RJ45 Category 6 rated T568B female jacks.

1. Each port shall be provided with an adhesive label with the associated cable identification number permanently identified in black lettering.

2. Provide jacks to match cable jacket color.

C. Cabling shall be terminated in rear (back) of patch panels with 110 type terminations. Panels shall contain rear wire management.

D. Camera Patch Panels shall be Leviton #69270 series or equal.

E. Patch Panels shall be labeled per Part 3 of these specifications.

2.10 ANALOG TELEPHONE PATCH PANELS (RJ45)

A. Patch Panels shall be 19" rack mountable.

B. Patch Panels shall be modular assemblies with (48) RJ45 Category 6 rated T568B female jacks.

1. Each port shall be provided with an adhesive label with the associated cable identification number permanently identified in black lettering.

2. Provide jacks to match cable jacket color.

C. Cabling shall be terminated in rear (back) of patch panels with 110 type terminations. Panels shall contain rear wire management.

1. Cables for work station jack shall be terminated in standard T568B configuration riser.

2. Riser cables from incoming analog telephone room shall be terminated one pair per jack on pins 4 and 5.

D. Workstation Data Patch Panels shall be Leviton #69270 series or equal.

E. Patch Panels shall be labeled per Part 3 of these specifications.

2.11 ANALOG TELEPHONE PATCH PANELS (110 BLOCKS)

A. Rack mountable 110 wiring blocks shall be Leviton #41DBR series, or equal, with the following features:

1. 110 Style, CAT 5E rated with 100-Pair capacity.

2. 5 pair connecting blocks.

3. 19" rack mountable panel.

4. Blocks shall accept #22 thru #26 AWG solid copper conductors.

5. Labels and clear label holders.

B. Patch Panels shall be labeled per Part 3 of these specifications.

2.12 COMMUNICATIONS OUTLETS

A. Each outlet shall include the number of jacks required per the Drawings.

B. Outlets shall provide with a nylon faceplate with color as indicated on drawings. Leviton #42080 or equal.

C. Analog Telephone, Data, VOIP, and Monitor jacks for workstations shall be Category 6 rated, T568B, 8-pin RJ45 female, and shall be color as indicated on the Drawings. Leviton #61110 series or equal.

D. Each jack shall be labeled per Part 3 of these specifications.

2.13 WIRELESS ACCESS POINTS

A. Each Wireless Access Point shall be furnished by Owner, set and wired by Contractor.

B. The Contractor shall leave 25'-0" coiled and tagged tails terminated with a CAT6 "Biscuit" jack at each Wireless Access Point location indicated on the Drawings.

C. Upon receipt of Owner furnished Wireless Access Points and wireless site survey; the Contractor shall install Wireless Access Points at the exact locations indicated.

2.14 FIBEROPTIC CABLE

A. Single-mode Fiber Optic Cable shall have the following features:

1. Single-mode optical fiber shall be an OS2 rated 9.2 micron core diameter, tight buffered with Plenum rated interlocking armor jacket.

2. The maximum attenuation of the fiber shall be 0.4 dB/Km at 1310 nm and 0.3 dB/Km at 1550 nm with no discontinuities along the length of the cabled fiber.

3. Each fiber optic cable jacket shall be printed with a minimum of the following information: Manufacturer, Manufacturer's part number, cable type, listing file number, number of pairs, listing type (i.e. OFNP, etc.), and sequential footage markings.

4. Each cable assembly shall be plenum and riser rated (NEC type OFNP), with interlocking armor jacket.

5. Fiber optic cable shall be Berk-Tek #PDPK024 series.

6. Indoor/outdoor rated fiber optic cable shall be Berk-Tek # PDP012-I/O series.

2.15 TELEPHONE TRUNK LINE CABLE

A. Copper trunk line cables (100-pair, etc) shall be Category 3, multi-pair (as indicated on Drawings), twisted, unshielded. Conductors shall be solid, #24 AWG bare copper.

B. Each pair shall be color coded. Color code shall be per BICSI standards.

C. The cable jacket shall be printed with a minimum of the following information: Manufacturer, Manufacturer's part number, cable type, listing file number, number of pairs, listing type (i.e. CMP, CMR, etc.), and sequential footage markings.

D. The ultimate breaking strength of the completed cable shall be 400 N (90 lbf) minimum.

E. The cable shall withstand a bend radius of 21.0 mm (0.83 in) at a temperature of -20° C ±1° C without jacket or insulation cracking.

F. Each cable assembly shall be plenum and riser rated (NEC type CMP).

G. Trunk line cables shall have a gray colored outer jacket.

2.16 CATV DISTRIBUTION BLOCKS

A. CATV distribution blocks shall be Technetix #OTRWXU-2 or similar with the following features:

1. 75 ohm impedance

2. (8) F-ports for drop cable connections

2.17 CATV TRUNK LINE CABLE

A. Coaxial Cables shall be by Commscope or similar with the following features:

1. Solid bare copper center conductor, 100% aluminum foil, and 90% aluminum braid.

2. Indoor cable assembly shall be plenum rated (NEC type CMP). Below grade cables shall be rated for outdoor/direct burial.

3. Cable jacket shall be printed with a minimum of the following information: Manufacturer, Manufacturer's part number, cable type, listing file number, listing type (i.e. CMP, etc.) and sequential footage markings.

4. Cable shall be terminated at each end with 75 ohm, male, compression type connectors as required for termination at distribution blocks.

B. Trunk line cables shall have a black colored outer jacket.

2.18 WORKSTATION CABLES

A. Workstation cables shall be Enhanced Category 6 rated, four-pair, twisted, UTP, plenum rated, non-continuous shielded cables. Conductors shall be solid, #23 AWG bare copper, with outer jacket color as indicated on Drawings.

B. Workstation cable pairs shall be color coded. The color code shall be as follows:

1. Pair 1: Blue-White/with extruded Blue stripe on White single

2. Pair 2: Orange-White/with extruded Orange stripe on White single

3. Pair 3: Green-White/with extruded Green stripe on White single

4. Pair 4: Brown-White/with extruded Brown stripe on White single

C. All cables shall be provided with plenum rated outer jacket (NEC type CMP, etc.). Refer to Drawings for required outer jacket color coding.

D. The cable jacket shall be printed with a minimum of the following information: Manufacturer, Manufacturer's part number, cable type, listing file number, number of pairs, listing type (i.e. CMP, etc.), and sequential footage markings.

E. Each cable shall be field labeled with a unique identification number per Part 3 of these specifications.

F. Enhanced CAT 6 Cables shall be one of the following:

1. Berk-Tek Lanmark-2000 6 UTP Series.
2. Superior Essex Data Gain CAT 6+ series.
3. General Cable Genspeed 6500 Premium CAT 6 series.

2.19 FIBER OPTIC PATCH CORDS

A. Patch cords shall be furnished and installed by the Owner.

2.20 CAT 6 PATCH CORDS

A. Patch cords shall be furnished and installed by the Owner.

PART 3 - EXECUTION

3.1 GENERAL

A. All cables, equipment, labeling, testing etc. shall be installed by the Contractor unless specifically noted otherwise on the Drawings. Installation shall be completed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner's Representative.

3.2 CABLE INSTALLATION

A. All cables shall be furnished and installed by the Contractor.

B. The Contractor shall furnish and install conduit sleeves thru wall and floor barriers as required for the installation of the cabling. Sleeves shall be electrical metallic tubing (EMT) and shall be sized for 40% fill for the cables passing thru the barrier, with a minimum 75% spare capacity. Minimum sleeve size shall be 1" thru walls, and 4" thru floors. Firestop all sleeves after cable installation.

C. All conduit stub-ups shall be sized as shown on the Drawings (3/4" minimum) with long sweep 90 degree elbows, insulating bushing terminated at each end, and nylon pull line.

D. Each cable shall be installed continuous full-length without any splices.

E. Cables shall be loosely bundled. Each bundle shall not include more than twenty cables.

1. Where cables are installed concealed above finished ceilings or exposed at structural ceiling, plenum-rated locking cable ties shall be used every 48" (Panduit #PLT Series or approved equal).
2. Where cables are exposed at terminal equipment in central closets, adjustable Velcro cable tie wraps shall be used (Panduit #HLC Series).

F. Cables installed without conduit and concealed above finished ceilings or exposed at structural ceiling shall be plenum rated and installed parallel and perpendicular to the building lines.

G. Cables shall be supported to the structural ceiling on 48" centers by use of threaded J-hook rings. Support rings to underside of structural ceiling and to walls.

H. All cable installation shall conform to the minimum and maximum bend radii as specified by the cable equipment manufacturer.

I. Each cable shall be terminated by the Contractor in accordance with manufacturer's installation requirements. Each termination shall be made that insures losses do not exceed their specified limits.

J. Patch cords shall be furnished by the contractor, installed by the Owner.

3.3 EQUIPMENT INSTALLATION

A. Equipment shall be installed at the locations indicated on the Drawings by the Contractor. These items shall be installed in a neat and craftsmanlike manner satisfactory to the Owner and Engineer.

B. Equipment racks shall be assembled such that mounting rails are exactly perpendicular to the base and shall be secured to the floor using appropriate anchors.

C. Jacks shall be installed to provide minimal signal impairment by preserving wire pair twists as closely as possible to the point of mechanical termination. The amount of untwisting in a pair as a result of termination to the jack shall be no greater than 0.5 inches (13 mm). Each cable jacket shall be maintained as close to the point of termination as possible and only stripped back as far as is required for proper termination.

D. Jacks shall be installed so that cables terminated to the jacks maintain a minimum bend radius of at least 4 times the cable diameter. Cables shall be terminated at the jack so that there is no tension on the conductors at the termination contacts.

E. Cable tray installation supports shall be independently and rigidly secured to the building structure. Auxiliary supports required to span obstructions (ductwork, piping, etc.) shall be unistrut channel or equal.

3.4 FIBEROPTIC INSTALLATION

A. Fiberoptic cable shall be properly anchored as it enters fiber patch panels. An anchor shall be attached to the cable jacket without excessive force and without crushing the cable jacket.

B. Fiberoptic patch panel adhesive or snap-in routing clips shall be secured to the inside of the adapter tray to allow the minimum cable bend radius. Provide storage of 25 feet (minimum) of fiber cable inside the tray.

C. Fiber optic cables shall be terminated at each end with hot-melt type LC fiber connectors (3M # 8601-D or approved equal).

3.5 LABELING AND IDENTIFICATION

A. Each jack shall be labeled with a dedicated unique identification number. Coordinate identification numbering convention with the Owner. Workstation labels shall be black text laser printed on clear self-laminating adhesive labels specifically for the text size selected.

B. Cables shall be labeled at both ends with a dedicated unique identification number to correspond with the jack it is connected to. Coordinate identification numbering convention with the Owner. Cable labels shall be black text laser printed on factory self-laminating adhesive labels specifically for the size and type of cable.

1. Handwritten labels and / or handwriting on the cables shall be unacceptable.

2. Labels shall comply with the requirements of TIA/EIA 606-A.

3. Labels shall be flexible vinyl or polyester.

C. Each Patch panel port shall be labeled with a dedicated unique to correspond with the jack it is connected to. Each port shall be provided with an adhesive label with the associated cable identification number permanently identified in black lettering.

3.6 SYSTEM TESTING

A. The Contractor shall perform all tests and shall be responsible for coordinating and supervising all testing work required by these documents and the authorities having jurisdiction.

1. All testing shall be scheduled in advance with the Owner. All testing will be witnessed by Owner.

B. Furnish materials, testing equipment, tools, labor and supervision necessary to accurately conduct and document all required tests.

C. Failure of defects in materials and workmanship revealed by tests shall be promptly corrected and test re-conducted.

3.7 FIBEROPTIC TESTING

A. Each Fiberoptic channel shall be tested as a whole. The channel shall include each cable strand and associated terminal ports in the patch panels.

B. Fiber optic channel tests shall be conducted using an Optical Time Domain Reflectometer.

1. Each fiber channel shall be tested for length, return loss, and propagation delay.

2. Attenuation measurements shall be conducted at 850 NM, 1300 NM, and 1550 NM. Fiber test equipment must be able to automatically determine loss budgets based on user input of number of connectors and type of fiber under test. Test equipment will calculate budget based on the appropriate allowable loss per kilometer from TIA standards.

3.8 CATEGORY 6 TESTING

A. Each channel shall be tested as a whole. The channel shall include each cable pair, jack, and patch panel.

B. Each channel shall be tested for length, DC continuity, NEXT, PSNEXT, attenuation, return loss, ELFEXT, and PSELFEXT using tester for Category 6 channel compliance.

C. Each channel shall be field tested for 100 MB transmission at 250 MHz.

D. Complete test and inspection records shall be conducted as described in EIA/TIA 568, 606, 607, and TSB/EIA-40, 67 and 75 telecommunication standards.

3.9 SYSTEM START-UP AND DOCUMENTATION

A. The Contractor shall be responsible for the initial start-up required for a fully operational system.

B. The Contractor shall furnish three complete Owner's Manuals including the following information:

1. Cut sheets and part numbers for all cables provided.

2. Instructions for the operation, preventative maintenance, trouble-shooting, and repair procedures for the various components of the system.

3. A record of all testing results and readings.

C. The Contractor shall provide As-Built drawings including plan layout, conduit runs, and wiring diagrams as finally installed.

1. At each outlet, the as-built drawings shall list all identification numbers associated with each jack. Coordinate identification numbering convention with the Owner.

2. Furnish two sets of 36" x 48" hard copies to Owner.

3. Furnish one PDF electronic copy to Owner, Architect, and Engineer.

4. Furnish one DWG (AutoCAD) electronic copy to Owner, Architect, and Engineer.

END OF SECTION 27 07 40

SECTION 27 07 70-PAGING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Furnish and install all, paging speakers, conduit, wire, and required accessories, to provide an extension to the existing Bogen Multicomm 2000 series paging system as indicated on the Drawings.

1.3 STANDARD PRODUCTS

A. Each major component shall bear the manufacturer's name, catalog number and UL label.

1.4 QUALIFICATIONS

A. Paging system equipment shall be as manufactured by Bogen Communications and distributed and supported by Paladin Protective Services of Cleveland, Ohio. Telephone: 216-441-6500.

B. The electrical contractor shall engage the services of the equipment provider and manufacturer to ensure proper installation and extension of the system.

C. It is the Electrical Contractor’s responsibility to verify that the wiring and equipment shown in the drawings is adequate for the system to be furnished. Any additional cabling, conduit, equipment, or devices required for a complete installation shall be provided as part of the base bid.

1.5 SUBMITTALS

A. Submittals shall include equipment specification sheets, electrical characteristics, performance data and floor plans/wiring diagrams.

1.6 SERVICE

A. The equipment manufacturer shall be represented by a local service organization, and the name of the organization shall be furnished to the Owner.

1.7 WARRANTY

A. The manufacturer shall guarantee all equipment from inherent mechanical or electrical defects for a period of one year from the date of installation. The manufacturer shall guarantee local service and local parts.

PART 2 - PRODUCTS

2.1 PAGING EQUIPMENT

A. Speakers

1. Flush ceiling mounted paging speaker assemblies shall each consist of a loudspeaker with line matching 25/70.7V transformer and 8" round white baffle (Atlas #SD72W), recessed rough-in backbox (Atlas #CS-958), and tile bridge (Atlas #81-8R).

2. Pendant mounted paging speaker assemblies shall each consist of a 8" round white loudspeaker with line matching 70.7V transformer (Atlas #PM8GD). Provide with required suspension hardware.

B. Provide head end equipment (ie. relay cards, amplifiers, etc.) as described on the drawings. Mount equipment in existing paging system cabinet in existing high school IT room.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall furnish and install, in accordance with manufacturer's shop drawings, all wiring, conduit, and outlet boxes for the erection of a complete system as described herein and as shown on the Engineer's drawings (Engineer's drawings are for bidding purposes only and to indicate intent). Quantity and type of wire and conduit size installed shall be suitable for equipment provided.

B. The Electrical Contractor, under the direct supervision of the equipment supplier, shall install the equipment and terminate associated wiring.

3.2 WIRING

A. The contractor shall furnish and install in accordance with manufacturer's instructions all wiring, conduit, and outlet boxes for the erection of a complete system as described herein and as shown on the Engineer's drawings.

B. Final connections between the equipment and the wiring system shall be made under the direct supervision of a representative of the manufacturer.

3.3 SYSTEM START-UP AND DOCUMENTATION

A. The Contractor shall be responsible for the initial start-up required for a fully operational system.

B. The Contractor shall furnish three complete Owner's Manuals, as required by Section 160051, including the following information:

1. Cut sheets and part numbers for all equipment and cables provided.

2. Instructions for the operation, preventative maintenance, trouble-shooting, and repair procedures for the various components of the system.

3.4 SYSTEM TUNING AND ACCEPTANCE

A. The Contractor shall adjust volume levels and speaker tap values to achieve optimum sound levels. The following measures shall be taken when tuning the system:

1. Tune the system and take into consideration the building systems ambient noise and the level of activity in the space during the course of normal hours.

2. After installation, the Contractor shall fine-tune the system with furnishings in place.

3. Make all final adjustments and tests to commission the system. All work to make the final adjustments shall be included in the base price.

4. Failure of defects in materials and workmanship revealed by tests shall be promptly corrected and test re-conducted.

B. Upon completion of testing, The Contractor shall coordinate a walk-thru with the Owner for final approval and sign-off. Walk-thru shall consist of a full demonstration of the system and shall be witnessed by the Owner and/or Owner's designated representative. Final adjustment to the paging system shall be made based on Owner feedback.

3.5 TRAINING OF PERSONNEL

A. Maintenance staff shall be thoroughly instructed in the use of the system by authorized distributor personnel.

END OF SECTION 270770

SECTION 27 07 71 - CLASSROOM SOUND SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The other Contract Documents complement the requirements of this Section. The General Requirements apply to the work of this Section.

1.2 SCOPE

A. Furnish and install all conduit, wire and equipment as indicated on the Drawings, and as required, for a completely operational classroom sound system.

1.3 CODES AND STANDARDS

A. Each major component shall bear the manufacturer's name, catalog number and UL label.

1.4 QUALIFICATIONS

A. In general, the basis of design is Teachlogic Products, contact Jeff Wallace at SoundCom tel: 614-799-1920. Equal equipment may be submitted for review and approval.

B. It is the Electrical Contractor’s responsibility to verify that the wiring and equipment shown in the drawings is adequate for the system to be furnished. Any additional cabling, conduit, equipment, or devices required for a complete installation shall be provided as part of the base bid.

C. The classroom sound system shall be as manufactured by one of the following:

1. TeachLogic
2. Crestron
3. Atlas Sound

D. The sound system speakers shall be as manufactured by one of the following:

1. TeachLogic
2. Crestron
3. Atlas Sound

1.5 SUBMITTALS

A. The equipment supplier shall provide shop drawings to include equipment specification sheets, schematics and wiring diagrams. Submittal shall also include a complete bill of material.

1.6 SERVICE

A. The Contractor shall guarantee availability of service by factory trained personnel from an authorized distributor by the equipment manufacturer. The distributor shall have available stock of the manufacturer's standard parts. On the premises maintenance shall be provided during normal working hours at no cost to the purchaser for a period of twelve (12) months from date of completion of installation unless damage or failure is caused by misuse, neglect, abuse or accident.

1.7 WARRANTY

A. The manufacturer shall guarantee all equipment from inherent mechanical or electrical defects for a period of one year from the date of installation. The manufacturer shall guarantee local service and local parts.

PART 2 - PRODUCTS

2.1 GENERAL

A. Each Classroom Sound System shall consist of an amplifier/mixer, speakers, wireless microphones and cradle battery charging station, wireless audio transmitter, infrared sensor, and all associated cabling and patch cords required for a complete system. Components shall meet requirements as described in the following sections.

2.2 AMPLIFIER

A. Audio amplifier capable of accepting no less than three (3) separate, balanced audio inputs and capability to accept wireless audio transmitter input, with independent gain control for each input, one balanced audio output to speakers (minimum), and appropriately sized to accommodate the connected speaker load (four 8-ohm speakers or less, 4-ohm output impedance minimum).

1. TeachLogic # Maxim III

B. Similar to requirements for previous amplifier, but for more than four 8-ohm speakers (maximum eight 8-ohm speakers).

1. TeachLogic # Spectrum

2.3 SPEAKERS

A. 6.5" diameter, white colored, 8-ohm, full-range audio speaker with multiple speaker taps and suitable for flush mounting in lay-in ceiling

1. TeachLogic # SP-628

B. 6.5" diameter, white colored, 8-ohm, full-range audio speaker with multiple speaker taps and suitable for mounting suspended from structural ceiling

1. TeachLogic # SP-628

2.4 WIRELESS MICROPHONES

A. Pendant-style unidirectional wireless microphone with lavalier cord, designed for hands-free mounting and operation and with integral rechargeable batteries and charging docking station.

1. Microphone: TeachLogic # Sapphire Microphone IRT-60N
2. Charging station: TeachLogic # BRC-60

2.5 WIRELESS AUDIO TRANSMITTER

A. Wireless audio transmitter with 3.5mm input (for audio) and integral power cable, to wirelessly transmit audio output from mobile or stationary TV monitor to local amplifier. Mount tight to backside of monitor. Refer to Part 3 of this specification for additional details.

1. TeachLogic # IRT-66

2.6 INFRARED CEILING SENSOR

A. Ceiling mounted infrared sensor with 360 degree coverage, capable of receiving wireless audio signal from wireless audio transmitter or wireless microphone and sending audio to local amplifier. Refer to Part 3 of this specification for additional details.

1. TeachLogic # ICS-55

2.7 AUDIO CABLING

1. Refer to Section 3.3 of this Specification for further details.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall furnish and install, in accordance with manufacturer's shop drawings, all wiring, conduit, and outlet boxes for the erection of a complete system as described herein and as shown on the Engineer's drawings (Engineer's drawings are for bidding purposes only and to indicate intent). Quantity and type of wire and conduit size installed shall be suitable for equipment provided.

B. The Electrical Contractor, under the direct supervision of the equipment supplier, shall install the equipment and terminate associated wiring.

C. All wiring shall be continuous between devices. No splicing is permitted.

3.2 CABLE INSTALLATION

A. All cables shall be furnished and installed by the Electrical Contractor.

B. Each cable shall be installed continuous full-length without any splices.

C. Cables installed without conduit and concealed above finished ceilings or exposed at structural ceiling shall be installed parallel and perpendicular to the building lines. Cables shall be loosely bundled with plenum-rated locking cable ties (Panduit #PLT Series or equal). Each bundle shall not include more than twenty cables. These cables shall be supported to the structural ceiling on 48" centers by use of threaded bridle rings (size as required for quantity of cables, 2" O.D. minimum). Clamp bridle rings to underside of structural ceiling and to walls. (Cable tray shall be utilized where provided).

D. Cables shall be neatly bundled at the terminal equipment in the closets with adjustable Velcro cable tie wraps (Panduit #HLC Series). Quantity as required to provide a neat installation.

E. All cable installation shall conform to the minimum and maximum bend radii as specified by the cable equipment manufacturer.

F. All conduits shall be sized as shown on the Drawings (3/4" minimum). Raceways shall utilize long sweep 90° bends at all locations where elbows are required. All raceways shall be terminated with insulating bushings. All spare raceways shall contain a nylon pull line.

G. Final connections between the equipment and the wiring system shall be made under the direct supervision of the Sub-Contractor.

3.3 AUDIO CABLING

A. Basis of design for audio wiring between amplifier and cart- or wall-mounted TV monitor (based on Teachlogic amplifier systems):

1. At the monitor end, a 6'-0" 3.5mm TRS (male-male) patch cable (for audio), and 6'-0" USB-A to USB-Micro (male-male) patch cable, both routed to wireless audio transmitter mounted to backside of TV monitor. Contractor shall ensure transmitter is properly mounted to allow seamless transmission to associated ceiling sensor.

2. At the amplifier end, integral 50'-0" shielded plenum-rated RCA (male-male) cable routed between amplifier and integral wireless audio ceiling-mounted sensor.

3. Basis of design for audio wiring between amplifier and speakers is Plenum-rated, #16 AWG 2/C unshielded cabling (WEST PENN # 25225B or approved equal). Contractor shall provide phoenix adapter terminals for termination of speaker cabling to amplifier, as required.

3.4 CABLE TERMINATION

A. Each cable shall be terminated by the Contractor in accordance with manufacturer's installation requirements. Each termination shall be made that ensures losses do not exceed their specified limits.

3.5 EQUIPMENT INSTALLATION

A. Equipment shall be installed at the locations indicated on the Drawings by the Contractor. These items shall be installed in a neat and craftsmanlike manner satisfactory to the Owner and Engineer.

3.6 SYSTEM TUNING AND ACCEPTANCE

A. The Contractor shall adjust volume levels and speaker tap values to achieve optimum sound levels in every room. The following measures shall be taken when tuning the system:

1. Tune the system and take into consideration the building systems ambient noise and the level of activity in the space during the course of normal hours.

2. After installation, the Contractor shall fine-tune the system with furnishings in place.

3. Make all final adjustments and tests to commission the system. All work to make the final adjustments shall be included in the base price.

4. Failure of defects in materials and workmanship revealed by tests shall be promptly corrected and test re-conducted.

B. Upon completion of testing, The Contractor shall coordinate a walk-thru with the Owner for final approval and sign-off. Walk-thru shall consist of a full demonstration of the system in each room, and shall be witnessed by the Owner and/or Owner's designated representative. Final adjustment to the classroom sound system shall be made based on Owner feedback.

1. Demonstration shall be representative of actual end-user experience in utilizing the system and shall consist of connecting to the local tv monitor via laptop (either HDMI or wireless connection) and playing a video with an audio component representative of what would be used in a classroom environment (coordinate requirements with Owner prior to walk-thru).

3.7 TRAINING OF PERSONNEL

A. Teaching staff as well as maintenance staff shall be thoroughly instructed in the use of the system by authorized distributor personnel.

END OF SECTION 27 07 71

SECTION 27 07 82-AUDIO/VISUAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The other Contract Documents complement the requirements of this Section. The General Requirements apply to the work of this Section.

1.2 SCOPE

A. Furnish and install all conduit, wire and equipment as indicated on the Drawings, and as required, for a completely operational classroom audio/visual system.

1.3 CODES AND STANDARDS

A. Each major component shall bear the manufacturer's name, catalog number and UL label.

1.4 QUALIFICATIONS

A. It is the Electrical Contractor's responsibility to verify that the wiring and equipment shown in the drawings is adequate for the system to be furnished. Any additional cabling, conduit, equipment, or devices required for a complete installation shall be provided as part of the base bid.

B. In general, the basis of design for the Audio/Visual System Wireless Codec is Crestron products, contact Keith Steingl tel: 224-955-1868. The Codec shall be manufactured by one of the following:

1. Crestron
2. Extron

C. In general, the basis of design for the HDBaseT transmitter / receiver system is Crestron products, contact Keith Steingl tel: 224-955-1868. The system shall be manufactured by one of the following:

1. Crestron
2. Extron
3. Legrand / CablesToGo

D. The Audio/Visual System wallplates shall be as manufactured by one of the following:

1. Cable Matters
2. Legrand / CablesToGo
3. Leviton
4. Belden

E. The Audio/Visual System cables shall be as manufactured by one of the following:

1. Cable Matters
2. Legrand / CablesToGo
3. Leviton
4. Belden

1.5 SUBMITTALS

A. The equipment supplier shall provide shop drawings to include equipment specification sheets, schematics and wiring diagrams. Submittal shall also include a complete bill of material.

1.6 SERVICE

A. The Contractor shall guarantee availability of service by factory trained personnel from an authorized distributor by the equipment manufacturer. The distributor shall have available stock of the manufacturer's standard parts. On the premises maintenance shall be provided during normal working hours at no cost to the purchaser for a period of twelve (12) months from date of completion of installation unless damage or failure is caused by misuse, neglect, abuse or accident.

1.7 WARRANTY

A. The manufacturer shall guarantee all equipment from inherent mechanical or electrical defects for a period of one year from the date of installation. The manufacturer shall guarantee local service and local parts.

PART 2 - PRODUCTS

2.1 AUDIO/VISUAL SYSTEM WIRELESS CODEC

A. Audio/visual system codec capable of permitting up to four end-users to simultaneously connect wirelessly and securely to Codec (with laptop and tablet end-user devices) to display content onto TV monitor for local presentation. Codec shall have capability to display up to four user's content on monitor simultaneously, and shall be minimally compatible with the following computer Operating Systems: Apple iOS, Windows 10, macOS, and Chrome OS. Codec output to monitor shall be HDMI and shall support HDCP 2.2 protocol and resolutions up to 4K60. Codec shall be provided with integral power supply (POE+ is acceptable).

1. Crestron # AM-3100-WF

B. Audio/visual system presentation adapter dongles with USB-C connection and ability to wirelessly transmit end-user display content to system codec, for guest presenter connectivity to wireless codec system. Adapter dongle shall have integral software drivers to allow automatic connectivity to codec with minimal end-user setup. Contractor shall provide two adapter dongle devices per Codec.

1. Crestron # AM-TX3-100

C. The following cables shall be furnished and installed by the Contractor for this device:

1. Male-male HDMI patch cable (for Codec connection to display device)
2. Cat-6 patch cable (for Codec connection to adjacent data jack)

2.2 HDBASET TRANSMITTER / RECEIVER

A. HDBaseT Transmitter / Receiver pair consisting of one single-gang wallplate-style transmitter with HDMI input and one receiver with HDMI and analog stereo audio outputs. System shall be capable of transmitting uncompressed digital and audio signals over CAT-type cable (via HDBaseT technology), and shall be capable of supporting HDCP 2.2 protocol, resolutions up to 4K60, and shall be capable of de-embedding audio signal from video source to allow for balanced 2-channel stereo audio signal to be routed to local amplifier. Device shall be provided with integral power supply.

1. Crestron # HD-EXT4-C

B. The following cables shall be furnished and installed by the Contractor for this device:

1. Male-male 6'-0" HDMI patch cable (for transmitter connection to end-user device)
2. Male-male 6'-0" HDMI patch cable (receiver connection to display device)
3. Horizontal Audio cabling (from receiver to local amplifier)
    a. Refer to Specification Section 27 07 71 for audio cabling description.

4. Horizontal Cat-6 cabling (for transmitter to receiver connection)

    a. Refer to Specification Section 27 07 40 - "Workstation Cables" section for horizontal data cabling requirements.

2.3 HDMI WALLPLATES

A. Wallplates shall be as described on the Electrical Symbol Schedule and as manufactured by one of the listed manufacturers in Section 1.4 of this Specification Section. Wallplates shall support HDMI 2.0 specifications, including high speed HDMI and support for up to 4K60 resolutions and up to 18Gbps bandwidth.

B. The following cables shall be furnished and installed by the Contractor for this device:

1. Male-male HDMI patch cable (for connection from backside of wallplate directly to display device HDMI input). Length as required.

2.4 HDMI CABLES

A. HDMI cables shall support HDMI 2.0 specifications, including high speed HDMI and support for up to 4K60 resolutions and up to 18Gbps bandwidth. Contractor shall verify exact length required for each room prior to ordering.

1. Passive HDMI cables shall be utilized wherever the entire HDMI cable length from audio/visual source to display (including HDMI patch cable length(s)) does not exceed 25 ft. This requirement excludes the distance between HDBaseT transmitter/reciever devices, where utilized.

2. Active HDMI cables are not permitted. The Contractor shall alert the Engineer for any HDMI cable runs that exceed 25 feet in length.

B. HDMI patch cables (for end-user connectivity or local device-device connectivity) shall have similar performance to HDMI cables and shall be 6'-0" in length for end-users and no longer than 6'-0" in length for device-device connectivity (ie, HDBaseT receiver HDMI output to monitor HDMI input).

2.5 AUDIO CABLES

A. Refer to Specification Section 27 07 71 for audio cable description and details.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall furnish and install, in accordance with manufacturer's shop drawings, all wiring, conduit, and outlet boxes for the erection of a complete system as described herein and as shown on the Engineer's drawings (Engineer's drawings are for bidding purposes only and to indicate intent). Quantity and type of wire and conduit size installed shall be suitable for equipment provided.

B. The Electrical Contractor, under the direct supervision of the equipment supplier, shall install the equipment and terminate associated wiring.

C. All wiring shall be continuous between devices. No splicing is permitted.

3.2 CABLE INSTALLATION

A. All cables shall be furnished and installed by the Electrical Contractor.

B. Each cable shall be installed continuous full-length without any splices.

C. Cables installed without conduit and concealed above finished ceilings or exposed at structural ceiling shall be installed parallel and perpendicular to the building lines. Cables shall be loosely bundled with plenum-rated locking cable ties (Panduit #PLT Series or equal). Each bundle shall not include more than twenty cables. These cables shall be supported to the structural ceiling on 48" centers by use of threaded bridle rings (size as required for quantity of cables, 2" O.D. minimum). Clamp bridle rings to underside of structural ceiling and to walls. (Cable tray shall be utilized where provided).

D. Cables shall be neatly bundled at the terminal equipment in the closets with adjustable Velcro cable tie wraps (Panduit #HLC Series). Quantity as required to provide a neat installation.

E. All cable installation shall conform to the minimum and maximum bend radii as specified by the cable equipment manufacturer.

F. All conduits shall be sized as shown on the Drawings (3/4" minimum). Raceways shall utilize long sweep 90° bends at all locations where elbows are required. All raceways shall be terminated with insulating bushings. All spare raceways shall contain a nylon pull line.

G. Final connections between the equipment and the wiring system shall be made under the direct supervision of the Sub-Contractor.

3.3 CABLE TERMINATION

A. Each cable shall be terminated by the Contractor in accordance with manufacturer's installation requirements. Each termination shall be made that ensures losses do not exceed their specified limits.

3.4 EQUIPMENT INSTALLATION

A. Equipment shall be installed at the locations indicated on the Drawings by the Contractor. These items shall be installed in a neat and craftsmanlike manner satisfactory to the Owner and Engineer.

3.5 SYSTEM COMMISIONING AND ACCEPTANCE

A. The Contractor shall engage the services of with factory-authorized personnel to ensure proper setup and functionality of all audio/visual system equipment (Codecs, extractors, etc.).

1. The Electrical Contractor shall be responsible for programming audio/visual system equipment and device settings for proper system operation.

2. Make all final adjustments and tests to commission the system. All work to make the final adjustments shall be included in the base price.

3. Failure of defects in materials and workmanship revealed by tests shall be promptly corrected and test re-conducted.

B. Upon completion of the installation, the system shall be completely commissioned by the Electrical Contractor, who will verify all connectivity and device operations to ensure trouble-free audio/visual system in each room.

C. Upon completion of commissioning, The Contractor shall coordinate a walk-thru with the Owner for final approval and sign-off. Walk-thru shall consist of a full demonstration of the system in each room, and shall be witnessed by the Owner and/or Owner's designated representative.

1. Demonstration shall be representative of actual end-user experience in utilizing the audio/visual system in each room and shall consist of connecting to the local tv monitor via laptop (either HDMI or wireless connection) and playing a video with an audio component representative of what would be used in a classroom environment (coordinate requirements with Owner prior to walk-thru).

3.6 TRAINING OF PERSONNEL

A. Teaching staff as well as maintenance staff shall be thoroughly instructed in the use of the audio/visual systems by authorized distributor personnel.

END OF SECTION 27 07 82

SECTION 28 00 51-BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Related and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. The following Division 26 sections also apply to the work of this Division:

26 00 52 - Tests
26 00 53 - General Wiring
26 00 54 - Cutting and Patching
26 00 55 - Temporary Power
26 00 56 - Firestopping
26 00 60 - Excavating, Trenching, Backfilling and Restoration
26 00 74 - Electrical Demolition and Salvage
26 01 11 - Conduit Systems
26 01 14 - Cable Tray
26 01 20 - Wire and Cable
26 01 25 - Pulling Cables
26 01 40 - Wiring Devices and Plates
26 01 52 - Wiring of Equipment Furnished Under Other Divisions
26 04 50 - Grounding

1.2 SCOPE

A. The work shall include the furnishing of systems, equipment and materials specified in this Division and as called for on the Drawings, to include: supervision, operations, methods and labor for the fabrication, installation, start-up and tests for the complete electrical installation.

B. Drawings for the work are diagrammatic, intended to convey the scope of the work and to indicate the general arrangement and locations of the work. Because of the scale of the Drawings, certain basic items such as conduit fittings, access panels, sleeves, pull and junction boxes may not be shown. Where such items are required by Code or by other Sections, or where they are required for proper installation of the work, such items shall be included.

C. Equipment Specification may not deal individually with minute items such as components, parts, controls and devices which may be required to produce the equipment performance specified or as required to meet the equipment warranties. Where such items are required, they shall be included by the supplier of the equipment, whether or not specifically called for.

1.3 ELECTRICAL REFERENCE SYMBOLS

A. Symbols used on the floor plans are defined in the Electrical Symbols Schedule on the Drawings. Not necessarily will all symbols scheduled be required for the project.

B. The symbols used for schematic or one line power and control wiring diagrams are American Standard Graphical Electrical Symbols and are published in American Standard Chart Z32.3.

1.4 PERMITS, INSPECTIONS AND CODES

A. The Contractor shall secure and pay for all permits and inspections required by the governing authorities for the prosecution of the electrical work of this division. All permits and certificates of inspection and approval signed by the controlling building department shall become the property of the Owner.

B. All wiring shall be in compliance with the current edition of the National Electric Code, applicable State and City regulations and OSHA. In cases of conflict between Code and Specifications, the more restrictive requirements shall govern.

1.5 VISIT TO THE SITE

A. The Electrical Contractor shall be required to visit the site of the work and familiarize himself with all such conditions affecting the work. The submission of his bid proposal shall presuppose his knowledge of all such conditions.

1.6 WORKMANSHIP

A. Employ only experienced craftsmen under direct supervision of a full time competent foreman.

B. Keep fully informed as to progress of work, so that work of this Division may be built into place in sufficient time to insure against delay to other trades, and to prevent misalignments or damage to electrical work.

1.7 COORDINATION, CONDUCT AND SCHEDULING OF WORK

A. Electrical drawings are diagrammatic, indicating general arrangement, approximate sizes, general locations of equipment and outlets. Verify dimensions in field; adjust to manufacturer's shop drawings. Do not scale drawings.

B. Architectural and structural drawings supersede electrical drawings. Determine that work of this Division can be accommodated within spaces provided. Notify Construction Manager and/or Architect of any interferences before starting installation.

C. Determine sizes, locations for chases, openings necessary for installation of electrical work; cooperate with other trades in setting of sleeves, inserts and hangers.

D. Coordinate this work with all trades, serving utilities and equipment suppliers. Arrange operation, submittal approvals and equipment delivery, so as not to delay installation or completion of any parts of interrelated work so that construction may proceed on schedule.

E. Cooperate with Mechanical trades in preparing interference drawings for points where there is possible conflict between trades. Exact locations of pipes, ducts, conduit based on field measurements with final arrangement to be determined by intra-trade agreements subject to Construction Manager's and/or Architect's review.

F. Architect reserves the right to make reasonable changes in indicated locations without extra cost to the Owner.

G. Drawings other than electrical drawings, and other sections of this Specification, may show or specify electrically operated equipment, wiring diagrams, etc. The Contractor shall examine all such drawings and specification sections and become familiar with the characteristics and required connections for all equipment.

H. Conduits, wiring and equipment shall be arranged substantially as indicated. Any change resulting in a savings in labor or material shall be made only in accordance with a contract change order. Deviations shall be made only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted to and approved by the Architect.

1.8 MATERIALS

A. All equipment and devices shall be new and shall conform to NEMA and Underwriters' Laboratories Standards. Where Specifications describe, or plans show, materials or equipment of higher quality than required by code and local ruling, the Drawings and Specifications shall govern the quality of the material or equipment.

B. Materials and equipment used as extensions to existing special systems shall be of matching electrical characteristics for satisfactory operation of the complete system and shall be of the same manufacture and design unless otherwise approved.

C. The Contractor shall submit proof, if requested by the Architect, that the materials, appliances, equipment or devices that he furnishes and installs under this contract, meet the requirements of the Underwriters' Laboratories, Inc. and its publications will be referred to hereinafter by the abbreviation UL, with or without additional identifying symbols.

D. The National Electrical Code (NEC) of the National Fire Protection Association, and Publications and Standards of the organizations listed below are referenced herein by the abbreviations noted in parentheses, with or without additional identifying symbols. Unless otherwise specified, all work shall be manufactured, tested and installed in accordance with such reference standards.

1. American Society for Testing and Materials (ASTM)
2. Underwriters' Laboratories, Inc. (UL)
3. Insulated Power Cable Engineers Association (IPCEA)
4. National Electrical Manufacturers Association (NEMA)
5. Institute of Electrical and Electronic Engineers (IEEE)
6. American National Standards Institute, Inc. (ANSI)
7. National Fire Protection Association (NFPA)

1.9 GUARANTEE

A. The Electrical Contractor shall guarantee for a period of one year that all work and equipment will remain free from all defects in workmanship and materials, and that it will comply with all the specific requirements of the Specifications and other Contract Documents governing the work.

B. All work found by the Architect to be defective will be replaced with new work meeting all the requirements of the Contract. The Electrical Contractor will bear all costs of supplying such new work, and installing and finishing same, and will assume all costs for replacing other work damaged by the removal and replacement of any of the work. The Electrical Contractor will bear all costs for freight, drayage and demurrage, and all labor in connection therewith.

1.10 SUBMITTALS

A. This Contractor shall prepare or obtain from the manufacturer certified shop or erection drawings of the items listed below. After Contractor’s review and approval of the proposed submittal, electronic copies of each shall be stamped and submitted to the Architect for approval before proceeding with installation or construction.

B. Approval drawings shall be submitted for the following items. Acceptable manufacturers shall be as described in the individual specification sections except where specifically noted below:

1. 28 07 21 – Fire Alarm System
2. 28 07 27 - Card Access System
3. 28 07 30 - Master Clock System
4. 28 07 80 - Closed Circuit Television System

C. Electronic submittals shall conform to the following requirements:

1. Electronic submittals shall be in Portable Document Format (.pdf)
    a. Electronic submittals shall include a transmittal.
    b. All portions of the electronic submittal shall be bound in a single .pdf file.

c. All content of the submittal shall be visible/readable and shall clearly indicate each item to be reviewed. Indicate specific options or accessories on shop drawings by pointing to, checking off, underlining, or other means.

d. File shall be named to match submittal contents.

e. Submittals shall include a specific notice of any deviation from the Contract Documents.

2. Electronic submittals shall include a Contractor review stamp that indicates review and approval by the Contractor prior to submission.

3. Electronic submittals shall be transmitted via an email.

a. One submittal per email.

b. Email shall clearly contain project name and contents of submittal.

4. Failure to conform to the requirements above may result in rejection.

5. The Reviewer shall return the submittals in a format and method appropriate for the Project and the response.

D. AutoCAD floor plans are available to Vendors and Contractors to assist in generation of shop drawings.

E. Prior to the signing of the contract the successful bidder shall submit to the Architect a list of manufacturers of the major items of equipment he proposes to furnish and the names of any subcontractors he proposes to employ.

1.11 ENGINEER'S REVIEW

A. Shop drawings shall be reviewed for general compliance. The Reviewer will make reasonable efforts to detect and correct errors, omissions and inaccuracies but shall not be responsible for failure to detect errors, omissions, or inaccuracies. Failure to detect errors, omissions and inaccuracies shall not relieve the Contractor of responsibility for the proper and complete installation in accordance with the intent of the Contract Documents.

B. The Engineer shall mark the shop drawings in one of the ways outlined below. See each description for interpretation of Engineers marks and Contractor responsibilities associated with each.

1. APPROVED: The submittal complies with the requirements of the specifications.

2. APPROVED AS NOTED: The submittal generally complies with the requirements of the specifications but some non-critical items which need to be corrected/coordinated are noted. The corrections shall be changed on the shop drawings submitted for inclusion in the Operations and Maintenance Manual. Re-submittal is not required unless noted otherwise.

3. REVISE AND RESUBMIT: The submittal generally complies with the requirements of the specifications but some critical items which need to be corrected/coordinated are noted. The submittal must be revised and resubmitted with all comments addressed.

4. REJECTED: The submittal does not comply with the requirements of the specifications. The submittal must be revised and resubmitted.

C. Approval of submittal items shall not eliminate the Engineers right to reject those items if defects are discovered prior to final acceptance of the completed work.

1.12 SUBSTITUTION

A. Bidders desiring to make a substitution for the specified brand or method shall list such proposed substitution. In each case state the difference in price where substitution is offered. If there is no difference in price, so state.

B. It shall be understood that the proposal submitted shall be based on the different branches of work and materials specified, and that the Owner is entitled to the use of the materials so specified. Substitution sheet shall be signed and dated by the Electrical Contractor and shall be formatted as follows:

BRAND OR MAKE SPECIFIED	PROPOSED SUBSTITUTION	ADD	DEDUCT

1.13 CONCRETE WORK

A. Concrete bases and pads for electrical equipment identified on the Drawings or as required shall be the responsibility of this Section.

B. Pads shall be 3" high with chamfered top edges unless otherwise noted on the Drawings. Pad sizes and locations shall be determined by the Electrical Contractor (do not scale from the Drawings).

C. This Contractor shall furnish all equipment anchor bolts and shall be responsible for their proper installation and accurate location.

1.14 NAMEPLATES AND LABELS

A. The Electrical Contractor shall furnish and install a system of nameplates designed to identify each piece of equipment, control unit thereon, and major distribution points. The following color scheme shall be used as a guide:

1. For switchboards, panelboards, control centers, all panels and remote control and indicating devices served by "normal" power, use black plastic, laminated, with white engraved letters to identify basic unit name and system, and each sub-system name and use. For equipment served by "emergency" power, use red plastic, laminated, with white engraved letters.

2. For fire alarm system cabinet and panels, use red laminated plastic with white engraved letters.

3. For telephone distribution cabinets and panels, use black plastic with white engraved letters.

4. Size of nameplates shall be made to readily differentiate between, and identify, equipment and usage. Nameplate identifying items that are transferred to emergency power shall carry a nameplate saying "EMERGENCY".

5. Exposed feeder conduits shall be identified as to load fed and voltage (Normal or Emergency) with 1" high black stenciled letters and numerals; conduit shall be marked every 50 feet. This shall include existing spare conduits.

B. Fasten nameplates to all enclosures by use of stainless steel sheet metal screws.

1.15 CLEANING AND PAINTING

A. Touch up and repair any damaged factory finishes on equipment and materials furnished. Other painting will be done under the Painting Division of the Specifications.

B. Remove any rust spots and prime with rust inhibitive paint any metal surfaces of electrical devices not provided with rust inhibitive coatings. Then apply one coat of paint in color as directed by Architect.

C. Swab interiors of conduits clean and dry before pulling wire. Clean interiors of boxes and cabinets before installing trims and covers.

1.16 TESTS

A. Systems shall be tested by the Electrical Contractor and placed in proper working order prior to demonstrating systems to Owner.

B. Perform such tests as required by authorities having jurisdiction over the site.

C. Perform tests as described in all subsequent sections of this Division and Related Documents.

1.17 DEMONSTRATIONS

A. Prior to acceptance of the work, the Contractor shall demonstrate to the Owner or his designated representative all features and functions of all systems and shall instruct the Owner in the proper operation of the systems. Each system shall be demonstrated once.

B. The demonstrations shall consist of not less than the following:

1. Point out the actual location of each component of a system and demonstrate its function and its relationship to other components within the system.

2. Demonstrate the electrical systems by actual "start-stop" operation showing how to work controls, how to reset protective devices, how to replace fuses, and what to do in an emergency.

3. Demonstrate communication, signal, alarm and detection systems by actual operation of the systems and show how to reset signal, alarm and detection devices.

C. Systems to be demonstrated shall include but not be limited to the following:

1. Alarm Detection and Signal Systems

2. Communication Systems

D. Contractor shall furnish the necessary trained personnel to perform the demonstrations and instruction, and shall arrange to have the manufacturer's representatives present to assist with the demonstrations.

E. Contractor shall coordinate dates and times for performing all demonstrations with the Owner.

1.18 OPERATION AND MAINTENANCE MANUALS

A. Electrical Contractor shall furnish to the Owner operation/maintenance manuals as described in the Division 1 Specifications.

B. Manuals shall meet or exceed all Division 1 Specification requirements and shall minimally include three (3) individually bound and indexed (thumb tabbed) manuals. Each manual shall provide operating instructions, maintenance manuals, spare parts listing, copies of warranties, wiring diagrams, inspection procedures and shop drawings on all equipment and systems.

C. Unless otherwise directed by the Division 1 Specification each manual shall be bound in a heavy-duty, 3 inch, three-ring vinyl covered binder with pocket folders for drawings and folded sheet information. Each binder shall be identified on both the front and the spine.

1.19 AS-BUILT DRAWINGS

A. As work progresses during the construction period, the Electrical Contractor shall record (on a dedicated set of bid drawings) any deviations from the design drawings. The completed record set of as-built drawings shall be delivered to the Architect prior to the Electrical Contractor's request for final payment.

B. As-built documentation shall meet or exceed all Division 1 Specification requirements.

1.20 PROJECT CLOSE-OUT

A. The installing Contractor shall contact the Engineers' office upon completion of the installation to request final inspection. At that time the following documents shall be assembled and provided for review at the job site:
- ☐ Photocopies of all signed electrical inspection permits.
- ☐ O & M Manuals (as described above).
- ☐ Photocopies of certified test results, as required by all specification sections.
- ☐ "As-Built" print set.
- ☐ Photocopy of Printout from Alarm Systems listing device addresses and custom labels.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION 28 00 51

SECTION 28 07 21-FIRE ALARM AND DETECTION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Contractor shall furnish all labor, materials, tools, and equipment required for the installation of an electrically-operated, supervised, automatic fire detection alarm system in accordance with the Drawings and Specifications.

B. The system shall operate as a low voltage, non-coded analog addressable fire alarm system.

1.3 STANDARDS AND CODES

A. The system furnished under this specification shall comply with the applicable provisions of the following standards and codes:

1. NFPA 70, National Electrical Code (Article 760)
2. NFPA 72, National Fire Alarm Code
3. State Codes
4. Local Codes and Ordinances
5. System shall be UL listed
6. System shall be FM approved

1.4 QUALIFICATIONS

A. Fire alarm equipment shall be as manufactured by Silent Knight or Fire-lite and distributed and serviced by one of the following:

1. Tri-state Security of Steubenville, Ohio. Contact Drew Hindman, telephone: 740-314-8414
2. Life Safety Systems of North Royalton, Ohio. Contact Dan Klag, telephone: 440-888-7960.

B. All fire alarm equipment to be furnished shall be the standard product of a single manufacturer, unless specifically noted otherwise, and shall display the manufacturer's name on each component.

C. System wiring shown on plans is based on Simplex equipment. It is the Electrical Contractor's responsibility to verify that the wiring shown on the drawings is adequate for the system to be furnished.

1.5 SERVICES

A. The equipment manufacturer shall have a local branch office staffed with trained, full-time employees who are capable of performing testing, inspection, repair and maintenance services for the fire alarm system.

1.6 WARRANTY

A. All components, parts and assemblies supplied by the manufacturer shall be guaranteed against defects in material and workmanship for a period of 12 months. Warranty service shall be provided by a trained specialist of the equipment manufacturer. The specialist shall be based in a fully staffed branch office located within a reasonable distance from the job site.

1.7 SUBMITTALS

A. Prior to installation of any equipment or raceways, submit shop drawings to Engineer for approval. Submittals shall include:

1. Equipment brochure with specification sheets including custom labeling designation.

2. Device wiring diagrams with required color coding noted.

3. Floor plans with wiring, device addresses and symbol schedule.

4. Riser diagrams with wire fill noted.

5. Battery calculations (per NFPA 72) and a listing of spare capacity on each power supply in the system under normal and alarm conditions.

6. Complete description of system operation.

7. Listing of all materials furnished with the system.

B. The submittal shall include six set of prints and six equipment brochures.

C. The custom label requirements shall be provided by the Owner. The system supplier shall provide the Owner with one set of approved shop drawings with address labels and a print out (on 8-1/2" x 11" sheets) with corresponding addresses and blank column for custom labels to be filled in by Owner.

D. Upon request, fire alarm floor/wiring plans in Autocad format may be obtained from the Engineer for development of shop drawings by the equipment manufacturer.

1.8 TRAINING

A. Provide on-site training for a minimum of four (4) persons on data display, alarm status descriptors, requesting data, execution of commands and request of logs. This training shall include a minimum of four (4) hours dedicated instructor time.

1.9 SYSTEM PROGRAMMING AND DOCUMENTATION

A. The Equipment Supplier shall be responsible for the initial programming required to make the system perform as outlined under System Operation of this Specification.

B. Custom label messages for the individual zones shall be defined at a later date (by the Owner) and shall be programmed by the Supplier (Supplier shall review all program labels with Owner prior to programming). The Owner reserves the right to request minor changes in the operation without incurring additional expense.

C. Complete documentation of the system programming shall be furnished to the Owner prior to final acceptance.

D. The Supplier shall furnish three complete Owner's Manuals including the following information:

1. Cut sheets and part numbers for all new initiating and indicating field devices, panel circuit boards, batteries, relays and various other components of the system.

2. Instructions for the operation, preventative maintenance, trouble-shooting, and repair procedures for the various components of the system.

3. Detailed programming instructions to allow the Owner to make system modifications and perform routine logging and status checking.

1.10 SYSTEM OPERATION

A. Upon activation of any manual pullstation, ceiling smoke detector, duct detector or water flow switch the following shall occur:

1. Activate all audio/visual devices throughout the building.

a. Signaling devices shall be the audio/visual type with synchronized flash and wired such that the audio signal may be silenced and the visual indicator shall remain flashing until the system is reset.

2. Release all magnetic door closures/hold-open devices throughout the building.

3. Display the alarm condition and sound the audible tone at the control panel.

4. Display the alarm condition and sound the audible tone at all annunciators.

5. Alert the Owner selected central station or local fire department service utilizing hardware in the control panel.

6. Shutdown associated air handling unit (duct detector alarm only).

B. Upon activation of the elevator equipment room smoke detector, elevator lobby smoke detector, or elevator shaft smoke detector, the fire alarm system shall send the associated elevator to the main egress level. In the event that the elevator lobby smoke detector on the main egress level is activated, the elevator shall be sent to an alternate floor as designated by the Owner.

C. Upon activation of any sprinkler system tamper switch. The following shall occur:

1. Display the supervisory condition and sound the audible tone at the control panel.

2. Display the supervisory condition and sound the audible tone at all annunciators.

D. The fire alarm system shall allow for loading and editing special instructions and operating sequences as required. The system shall be capable of on-site programming to accommodate systems expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control panel. Loss of primary and secondary power shall not erase the instructions stored in memory. Full flexibility for selective input/output control functions based on ANDing, ORing, NOTing, timing and special coded operations shall also be incorporated in the resident software programming of the system.

E. Resident software shall allow for full configuration of initiating circuits so that additional hardware shall not be necessary to accommodate changes in, for instance sensing of normally open contact devices to sensing of normally closed contact devices, or from sensing of normally open contact devices to sensing a combination of current limited and non-current limited devices on the same circuit and being able to differentiate between the two, or changing from a non-verification circuit to a verification circuit or vice-versa.

F. The system shall have the capability of recalling alarms and trouble conditions in chronological order for the purpose of recreating an event history.

G. When the system is operating on battery power, a trouble condition shall be generated after power outage exceeds 15 seconds. When AC power is restored, the system shall revert to the 120 VAC, 60 Hz supply without any manual restart procedures.

H. The system shall detect faults in the wiring and power loss. Upon detection of these conditions, a local alarm and indication light shall operate at the fire alarm panel and also at the remote annunciator.

I. The system shall contain independently supervised initiation circuits and individually addressable devices. The alarm activation of any initiating circuit shall not prevent the subsequent alarm operation of any other initiation circuit.

J. Auxiliary manual controls shall be supervised so that an "off normal" position of any switch shall cause a system trouble.

K. Each independently supervised circuit shall include a discrete LCD readout to indicate disarrangement condition per circuit.

L. The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be audibly and visually indicated at the control panel and the remote annunciator.

M. All system control and monitor modules shall be electrically supervised for module placement. Should a module become disconnected the system trouble indicator shall illuminate and the audible trouble signal must sound.

N. The system shall have provisions for disabling and enabling all circuits individually for maintenance or testing purposes.

O. System Reset

1. The "System Reset" button shall be used to return the system to its normal state after an alarm condition has been remedied. Printed messages shall provide operator assurance of the sequential steps (i.e.: "IN PROGRESS", "RESET COMPLETED", and "SYSTEM NORMAL") as they occur, should all alarm conditions be cleared.

2. Should an alarm condition continue to exist, the system will remain in an abnormal state. System control relays shall not reset. The panel Priority Alarm LED shall remain on. These points will not require acknowledgment if they were previously acknowledged.

PART 2 - PRODUCTS

2.1 FIRE ALARM CONTROL PANEL

A. The fire alarm control panel shall be an analog addressable type, with LCD display, capable of communication with up to 198 analog/addressable field devices via a twisted pair of wires. A single cabinet must house all controls, power supplies, signal circuits, etc. Approved equipment:

1. Silent Knight #6808

2. Fire-Lite #ES-200X

B. Panel shall contain four independently supervised and independently fused 24 VDC indicating circuits for audio/visual devices. Each independently supervised circuit shall include a discrete amber "trouble" LED to indicate disarrangement conditions per circuit. Provide additional cards/hardware to the base panel as required to meet this signal circuit requirement. The panel shall include support for synchronized visual device operation.

C. The control panel shall receive 120 VAC power via a dedicated circuit breaker as noted on the plans. The incoming power to the system shall be supervised so that any power failure shall be audibly and visually indicated at the control panel. A "power on" LED shall be displayed continuously while AC power is present.

D. The control panel shall be provided with sufficient battery capacity to operate the entire system upon loss of normal supervisory mode for a period of twenty-four (24) hours with five (5) minutes of alarm indication at the end of this period. The system shall automatically transfer to the standby batteries upon power failure. All battery charging and recharging operations shall be automatic. Batteries, once discharged, shall recharge at a rate to provide a minimum of 70% capacity in 12 hours.

E. The control panel is to have a dedicated system trouble LED and a dedicated trouble acknowledge switch.

F. Panel shall contain an auto dialer for central station tie or for alerting the local Fire Department of a trouble or alarm condition.

2.2 ADDITIONAL SIGNAL POWER SUPPLY

A. The auxiliary power supply shall be enclosed in a wall mountable ventilated panel and shall contain the equipment and controls necessary to operate a minimum of four 24VDC signal circuits. The panel in its base configuration shall have circuits rated for 2 amp maximum each and the panel shall at the minimum have the capacity of 8 amps overall. It shall be possible to add additional circuits and ampere capacity to the panel. The panel shall support operation of synchronized visual devices.

B. The panel shall be furnished with adequate battery capacity to serve the potential loads for which it is equipped. The panel shall have an integral battery charger. The panel shall operate on 120VAC.

1. Silent Knight #SK-PS10.

2. Fire-Lite #FL-PS10(C).

2.3 TERMINAL CABINETS

A. Terminal cabinets shall consist of a 26"W x 14"H x 4"D surface mounted cabinets with lockable hinged door, terminal strips with I.D. labels for field wiring and red finish. Space Age Electronics # TCXA 64. All wiring and terminal strips shall be labeled in field.

2.4 FIELD DEVICES

A. Annunciators shall contain 80 character LCD display (for custom message display), audible horn, keylock, and pushbuttons for signal silence, alarm acknowledge, and (4) auxiliary controls.

1. Silent Knight #6860.

2. Fire-Lite #ANN-80.

B. Addressable smoke detectors shall have an analog addressable base with LED indicator and photoelectric head.

1. Silent Knight #SK-PHOTO-W series.

2. Fire-Lite #SD365 series.

C. Smoke detectors for use in the elevator recall system shall be addressable type with an auxiliary 120 volt rated contact, LED indicator on base and photoelectric head.

1. Silent Knight #SK-PHOTO-W series with relay base Silent Knight #B224RB series.

2. Fire-Lite #SD365 series with relay base Fire-Lite #B224RB.

D. Duct smoke detector assembly shall be an analog addressable type with photoelectric head, sampling tubes and 120 volt normally open auxiliary contacts and remote alarm indicator station.

1. Silent Knight #SK-DUCT series.

2. Fire-Lite #D355PL series.

E. Remote key reset/test station for each duct detector shall have an LED (to illuminate when duct detector is in alarm) and key switch (for testing the alarm circuitry). Key reset/test station shall be suitable for mounting in flush ceiling mounted 1-gang box.

1. Silent Knight #RTS151KEY

2. Fire-Lite #RTS151KEY.

F. Addressable manual pull stations shall be metal red, double action type with red flush trim ring.

1. Silent Knight SK-PULL-DA.

2. Fire-Lite BG-12LX.

G. Audio/visual devices shall be 24 VDC horn, and 75 candela (minimum) xenon strobe with clear lens and red "FIRE" lettering (75/15 candela strobes are not acceptable).

1. System Sensor #P2RL

H. Visual only devices shall be 24 VDC with 75/15 candela xenon strobe with clear lens and red "FIRE" lettering.

1. System Sensor #P2RL

I. Addressable control modules shall contain two form C contacts, rated at 2 amperes, 120 volt.

1. Silent Knight #SK-RELAY

2. Fire-Lite #CRF300

J. Addressable monitor modules shall be individual type with integral end of line resistor.

1. Silent Knight #SK-MONITOR series.

2. Fire-Lite #MMF-300 series.

K. Door Hold-Open magnets shall be 24 VDC, semi-flush wall mounting type.

1. Honeywell #DH24120

2. Fire Lite #FM798

PART 3 - EXECUTION

3.1 WIRING

A. The Contractor shall furnish and install, in accordance with manufacturer's shop drawings all wiring, conduit, and outlet boxes for the erection of a complete system as described herein and as shown on the Engineer's drawings (Engineer's drawings are for bidding purposes only and to indicate intent). Quantity and type of wire and conduit size installed shall be suitable for equipment provided. Color code shall be used and all wires shall be tagged at all junction points and shall test free from ground or crosses between conductors.

B. Junction boxes located above lay-in ceilings shall be painted red.

C. Each fire alarm device shall be identified with its specific address or circuit (signal devices) using self laminating labels. Self laminating labels shall be Brothers P-Touch type utilizing industrial grade tape, without exception.

D. Wiring shall be color-coded throughout and test free and clear of opens, grounds and crosses between conductors.

E. All initiating and indicating wiring shall be continuous between devices. No splicing is permitted.

3.2 TESTING

A. Upon completion, the Contractor shall conduct a total system test for the Owner, and Engineer. At minimum, this test shall include:

1. Operating all initiating devices.

2. Verify line supervision of each initiating circuit and indicating circuit.

3. Verifying operation of each indicating device.

4. Verifying complete system operation, including interface with other equipment.

5. Wiring shall be checked and tested by the Electrical Contractor in accordance with the instructions provided by the manufacturer to insure that the system is free of grounds, shorts, opens, and that the insulation resistance between current carrying conductors is 10 Megohms or greater.

3.3 DOCUMENTATION

A. The Contractor shall provide three sets of bound detailed written operating instructions and drawings including plan layout, conduit runs, and wiring diagrams as finally installed as required by Section 260051.

B. Upon completion of the installation, a factory-trained technician shall perform all necessary tests and adjustments and who shall then file a letter of certification with the Owner indicating that the system functions and conforms to prescribed standards.

C. The Electrical Contractor shall schedule all testing in advance with the Owner and the Fire Department. All testing will be witnessed by Owner and Fire Department personnel.

END OF SECTION 28 07 21

SECTION 31 10 00

SITE CLEARING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
1. Protecting existing trees, shrubs, groundcovers, plants and grass to remain.
2. Removing existing trees, shrubs, groundcovers, plants and grass.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and removing site utilities.
7. Temporary erosion and sedimentation control measures.

B. Related Sections include the following:
1. Division 01 Section "Temporary Facilities and Controls" for temporary utilities, temporary construction and support facilities, temporary security and protection facilities, and temporary erosion and sedimentation control procedures.
2. Division 01 Section "Temporary Tree and Plant Protection" for protecting trees remaining on-site that are affected by site operations.
3. Division 01 Section "Execution" for verifying utility locations and for recording field measurements.
4. Division 31 Section "Earth Moving" for soil materials, excavating, backfilling, and site grading.
5. Division 32 Sections "Turf and Grasses" and "Plants" for finish grading including preparing and placing planting soil mixes and testing of topsoil material.

1.3 DEFINITIONS

A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other non-soil materials.

B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

B. Record drawings, according to Division 01 Section "Project Record Documents," identifying and accurately locating capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.7 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
   1. Do not proceed with work on adjoining property until directed by Architect.

C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

D. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

E. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 31 Section "Earth Moving."
   1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly flag trees and vegetation to remain or to be relocated.

C. Protect existing site improvements to remain from damage during construction.
   1. Restore, repair or replace damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction and sediment and erosion control Drawings.

B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE PROTECTION

A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.
   1. Do not store construction materials, debris, or excavated material within fenced area.
   2. Do not permit vehicles, equipment, or foot traffic within fenced area.
   3. Maintain fenced area free of weeds and trash.

B. Do not excavate within tree protection zones, unless otherwise indicated.

C. Where excavation for new construction is required within tree protection zones, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.
   1. Cover exposed roots with burlap and water regularly.
   2. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
   3. Coat cut faces of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
   4. Backfill with soil as soon as possible.

D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Landscape Architect.
   1. Employ an arborist, licensed in jurisdiction where Project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.
   2. Replace trees that cannot be repaired and restored to full-growth status, as determined by Landscape Architect.

3.4 UTILITIES

A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
   1. Arrange with utility companies to shut off indicated utilities.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Architect not less than two days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Architect's written permission.

C. Excavate for and remove underground utilities indicated to be removed.

D. Removal of underground utilities is included in Division 22 and Division 33 Sections covering site utilities.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.
1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
3. Grind stumps and remove roots, obstructions, and debris extending to a depth of 24 inches below exposed subgrade.
4. Use only hand methods for grubbing within tree protection zone.
5. Chip removed tree branches and stockpile in areas approved by Architect.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
1. Remove subsoil and non-soil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.
1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within tree protection zones.
3. Dispose of excess topsoil as specified for waste material disposal.
4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

3.8 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION

SECTION 31 20 00

EARTH MOVING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses, and exterior plants.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for concrete slabs-on-grade.
4. Subbase course for concrete walks and pavements.
5. Subbase and base course for asphalt paving.
6. Subsurface drainage backfill for trenches.
7. Excavating and backfilling for utility trenches.
8. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Sections:
1. Division 01 Section "Construction Progress Documentation" or "Photographic Documentation" for recording preexcavation and earth moving progress.
2. Division 01 Section "Temporary Facilities and Controls" for temporary controls, utilities, and support facilities; also for temporary site fencing if not in another Section.
3. Division 01 Section "Temporary Tree and Plant Protection" for protecting and trimming trees to remain.
4. Divisions 21, 22, 23, 26, 27, 28, and 33 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.
5. Division 31 Section "Site Clearing" for temporary erosion and sedimentation control measures site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
6. Division 32 Section "Turf and Grasses" for finish grading, including preparing and placing planting soil for turf areas.
7. Division 32 Section "Plants" for planting bed establishment and tree and shrub pit excavation and planting.
8. Division 33 Section "Subdrainage" for drainage of foundations landscaped areas.
9. "Report of Geotechnical Subsurface Exploration" by Professional Service Industries Inc. for additional requirements.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade, pavement or other surface material that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
   1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
   2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
   3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil and/or granular materials used to raise existing grades.

H. Cleveland LSM/Flowablel Fill: Self-compacting cementitious material used as backfill in place of compacted granular material per city of Cleveland specifications.

I. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by a geotechnical testing agency, according to ASTM D 1586.

J. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

K. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

L. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

M. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following manufactured products required:
   1. Geotextiles.
   2. Controlled low-strength material, including design mixture.
   3. Each type of plastic warning tapes.

B. Samples: For the following products, in sizes indicated below:
   1. Geotextile: 12 by 12 inches.
   2. Warning Tape: 12 inches long, of each color.

1.5 INFORMATIONAL SUBMITTALS

A. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D 2487 of each on site and borrow soil material proposed for fill and backfill.
2. Laboratory compaction curve according to ASTM D 698 for each on-site and borrow soil material proposed for fill and backfill.

B. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

1.6 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: An independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock definition testing, as documented according to ASTM D3740 and ASTM E 548.

B. Preexcavation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.7 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.
1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.
3. Contact utility-locator service for area where Project is located before excavating.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

C. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

PART 2 PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GC, GP, GM, SW, SC, SP, and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter. All materials shall be approved by project geotechnical engineer.

C. Unsatisfactory Soils: Soil Classification Groups ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction, and any materials deemed unsatisfactory by project geotechnical engineer.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

F. Premium Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

I. Engineered Fill: Engineered fill shall consist of non-expansive materials. Pyritic and/or potentially expansive materials such as mine tailings, slag, shale fragments and soil mixed with more than 5 percent of shale fragments should not be used as engineered fill material. Materials selected for use as engineered fill should contain less than 3 percent by weight of organic matter, waste construction debris, or other deleterious materials. Fill materials should generally have a Standard Proctor maximum dry density greater than 110 pounds per cubic foot, an Atterberg liquid limit less than 40, a plasticity index less than 15 and a maximum particle size of 2 inches or less.

J. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

K. Sand: ASTM C 33; fine aggregate.

L. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
1. Survivability: Class 2; AASHTO M 288.
2. Grab Tensile Strength: 157 lbf; ASTM D 4632.
3. Sewn Seam Strength: 142 lbf; ASTM D 4632.
4. Tear Strength: 56 lbf; ASTM D 4533.
5. Puncture Strength: 56 lbf; ASTM D 4833.
6. Apparent Opening Size: No. 40 sieve, maximum; ASTM D 4751.
7. Permittivity: 0.5 per second, minimum; ASTM D 4491.

8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
1. Survivability: Class 2; AASHTO M 288.
2. Grab Tensile Strength: 247 lbf; ASTM D 4632.
3. Sewn Seam Strength: 222 lbf; ASTM D 4632.
4. Tear Strength: 90 lbf; ASTM D 4533.
5. Puncture Strength: 90 lbf; ASTM D 4833.
6. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
7. Permittivity: 0.02 per second, minimum; ASTM D 4491.
8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.3 CONTROLLED LOW-STRENGTH MATERIAL

A. Controlled Low-Strength Material: Self-compacting, flowable concrete material produced from the following:
1. Portland Cement: ASTM C 150, Type I.
2. Fly Ash: Not allowed.
3. Fine Aggregate: ODOT Specification 703.03 fine aggregate for motar or grout. The use of spent foundry sand or core sand is strictly prohibited.
4. Foaming Agent: ASTM C 869.
5. Water: ASTM C 94/C 94M.
6. Air-Entraining Admixture:
   a. One of the following:
      1) Rheofill by Master Builders.
      2) Flow Air by Axim.
      3) Dara Fill by W.R. Grace.
   b. Air-enhancing admixture shall be incorporated in the mix that will have the effect of lowering the water/cement ratio between 95 and 105 lbs/cubic foot. The air entrained content for the mix shall be 30 percent to eliminate/minimize excessive water and segregation.
   c. The mix design shall be proportioned as follows:
      1) Cement (Type 1) 50 lbs/cubic yard.
      2) Sand (SSD) 2475 lbs/cubic yard .
      3) Water 25 gallons/cubic yard.
      4) Admixture (Air) 3 oz/cubic yard.

2.4 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:
1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously

inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris obstructions, and deleterious materials from ground surface is specified in Division 31 Section "Site Clearing," during earth moving operations.

C. Protect and maintain erosion and sedimentation controls during earth moving operations.

D. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
   1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
   2. Install dewatering system, to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
   1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
   2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
      a. 24 inches outside of concrete forms other than at footings.
      b. 12 inches outside of concrete forms at footings.
      c. 6 inches outside of minimum required dimensions of concrete cast against grade.

d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
e. 6 inches beneath bottom of concrete slabs-on-grade.
f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
   1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
   2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.
   1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
   1. Clearance: As indicated on drawings.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
   1. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
   2. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.8 SUBGRADE INSPECTION

A. Notify project Geotechnical Engineer when excavations have reached required subgrade.

B. If project Geotechnical Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 20 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by project geotechnical engineer, and replace with compacted engineered fill. Unstable soils can also be stabilized by choking the exposed bearing surface with crushed limestone or similar coarse aggregate. See “Report of Geotechnical Subsurface Exploration” for additional information.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.
   1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
   1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:
   1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
   2. Surveying locations of underground utilities for Record Documents.
   3. Testing and inspecting underground utilities.
   4. Removing concrete formwork.
   5. Removing trash and debris.
   6. Removing temporary shoring and bracing, and sheeting.
   7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.12 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section "Cast-in-Place Concrete."

D. Trenches under Roadways: After installing and testing place and compact pipe bedding to a maximum depth of 12" over top of pipe. Place final backfill of controlled low-strength material to final subgrade elevation.

E. Place and compact initial backfill of subbase material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe or conduit.
   1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

G. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.13 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:
   1. Under grass and planted areas, use satisfactory soil material.
   2. Under walks and pavements, use satisfactory soil material.
   3. Under steps and ramps, use engineered fill.
   4. Under building slabs, use engineered fill.
   5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
   1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
   1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 98 percent.
   2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 98 percent.

3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 98 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 98 percent.

3.16 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1/2 inch.
3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.17 SUBSURFACE DRAINAGE

A. Subdrainage Pipe: Specified in Division 33 Section "Subdrainage."

3.18 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase and base course under pavements and walks as follows:
1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place base course material over subbase course under hot-mix asphalt pavement.
3. Shape subbase and base course to required crown elevations and cross-slope grades.
4. Place subbase and base course 6 inches or less in compacted thickness in a single layer.
5. Place subbase and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
6. Compact subbase and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 98 percent of maximum dry unit weight according to ASTM D 698.

3.19 DRAINAGE COURSE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course 6 inches or less in compacted thickness in a single layer.
3. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.

4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 98 percent of maximum dry unit weight according to ASTM D 698.

3.20 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length, but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.21 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION

SECTION 31 22 19

FINISHED GRADING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The requirements of each Contract Document apply to the Work of this Section.

B. Refer to Division 1 for further technical requirements.

1.2 WORK OF THIS SECTION

A. Furnish all labor, materials and equipment to complete all work as herein specified and as indicated on the Drawings.

1.3 APPLICABLE SPECIFICATIONS

A. The following standards form a part of these specifications:

ODOT Specifications (Ohio Department of Transportation, Construction & Materials Specification):

Item 207 Temporary Soil Erosion and Sediment Control

Item 653.02 Topsoil

1.4 PREPARATION

A. Builders' refuse and rubbish wherever encountered shall be removed from the site.

B. Obvious obstructions below grade shall be removed.

C. Excavated material not usable as fill shall be removed from the site.

PART 2 - PRODUCTS

2.1 ADDITIONAL EARTH

A. Provide additional topsoil necessary to bring grade to required elevations. Provide topsoil meeting this Specification. Submit verification that topsoil complies for the Architect's review. Topsoil shall be classified as Sandy Loam and contain at least 6% organic matter; have a pH of 5.5 – 7.0. and shall meet the following mechanical analysis –

Sieve Size	Percent by Weight
1”	99-100
1/4”	97-99
No. 100 Mesh	40-60
No. 200 Mesh	20-40

B. See additional topsoil requirements for plant beds and backfill for plantings in Section 3.3 A. 2.

2.2 TOPSOIL

A. Topsoil from stockpiles at the site shall be without admixture of sub-soil and shall be screened. Filter for screen shall have openings with a maximum size of 1/2” openings. Topsoil shall be free of heavy clay, grass clods, stones or gravel over 1/2”, lumps, roots, sticks, and other foreign material.

B. Topsoil shall not be stripped or spread or in any way used or worked while wet, muddy or in frozen condition. Topsoil shall not be stored on paved areas.

PART 3 - EXECUTION

3.1 TOPSOIL AREAS

A. Site land area not occupied by plant beds, buildings, walks, pavement, etc., shall be prepared for lawn, as indicated on the Drawings. Topsoil shall be placed within the contract limit lines as shown on the Drawings.

3.2 LAWN PREPARATION (SUB-GRADE)

A. The sub-grade shall be brought to a uniform grade, allowing for topsoil depth noted on Drawings.

B. All areas to be topsoiled shall have sub-grade soil loosened to a depth of 6" and graded to remove all ridges and depressions. Subgrade shall be parallel to proposed finish grade. All stones over 1/2" in any dimension, sticks, rubbish and other extraneous matter shall be removed during this operation. No heavy objects, except lawn rollers, shall be moved over lawn areas after the sub-grade soil has been prepared unless the sub-grade soil is again loosened and prepared as specified above before topsoil is spread. After the sub-grade soil has been prepared, topsoil shall be spread evenly thereon by approved method to the required depth, and the area then rolled with a 200 pound roller. No topsoil shall be spread in a frozen or muddy condition. Where topsoil already lies in place, the topsoil surface shall be loosened to a depth of four inches (4") and all rocks, tree and weed roots removed prior to fine grading.

C. For areas to be planted, the finished surface shall conform to the finished grade; free of hollows or other inequalities, and of stones, sticks and other extraneous matter.

3.4 PLANT BED (SUB-GRADE)

A. The sub-grade shall be brought to a uniform grade, allowing for topsoil depth noted on Drawings.

B. All areas to receive topsoil bed mix shall have sub-grade soil loosened to a depth of 12" and graded to remove all ridges and depressions. Subgrade shall be parallel to proposed finish grade. All stones over 1/2" in any dimension, sticks, rubbish and other extraneous matter shall be removed during this operation. No heavy objects, except lawn rollers, shall be moved over lawn areas after the sub-grade soil has been prepared unless the sub-grade soil is again loosened and prepared as specified above before topsoil is spread. After the sub-grade soil has been prepared, topsoil shall be spread evenly thereon by approved method to the required depth, and the area then rolled with a 200 pound roller. No topsoil shall be spread in a frozen or muddy condition. Where topsoil already lies in place, the topsoil surface shall be loosened to a depth of four inches (12") and all rocks, tree and weed roots removed prior to fine grading.

C. For areas to be planted, the finished surface shall conform to the finished grade; free of hollows or other inequalities, and of stones, sticks and other extraneous matter.

3.3 TOPSOIL DEPTH

A. Topsoil areas, when prepared and completed, shall be a uniform layer of loam in the areas indicated on the Drawings and with the depths as noted below.

1. Topsoil shall be a minimum of 6” in lawn areas.

2. Plant beds – bed mix shall be applied in a min. 12” layer. Soil utilized in all plant beds and as backfill for all plant excavations shall be approved screened sandy loam plant bed soil mix without admixture of subsoil and shall be reasonably free of stones, lumps, plants and their roots, sticks, or other extraneous matter, and shall not be used for planting operations while in a frozen or muddy condition. Minimum organic content for plant bed soil mix – 8%. Plant bed soil mix shall be a mixture of approximately 1/3 topsoil, 1/3 decomposed leaf humus and 1/3 coarse sand. Provide soil submittal with soil tests for approval.

3.4 UTILITIES

A. The installation of all underground utilities, drain tile, curbs, etc., shall be completed before final sub-grading and placing of loam.

3.5 FINE GRADING

A. Topsoil shall be fine graded, removing stones over ½", lumps, etc., and the entire areas shall be left ready for planting. The Architect and the Owner shall be notified as to the exact day that the areas will be ready for planting.

3.6 SOIL TESTS

A. Contractor shall take representative samples from all topsoil to be used on site and have tests made by a state or commercial soil testing laboratory using methods approved by the "Association of Official Agricultural Chemists" or the State Agricultural Experiment Station. Tests to be for quality of topsoil as defined under ODOT Item 653.02 and for requirements (including macronutrients and micronutrients) pertaining to ornamental planting and lawns correct deficiencies as required. Fertilizer formulation noted under other Sections of these Specifications may be adjusted if tests results so indicate.

3.8 TEMPORARY EROSION CONTROL

A. Perform temporary soil erosion and sediment control operations in accord with ODOT Item 207 by Architect acceptable methods.

END OF SECTION

SECTION 31 23 19

DEWATERING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes construction dewatering.

B. Related Sections:
1. Division 01 Section "Construction Progress Documentation" for recording preexisting conditions and dewatering system progress.
2. Division 31 Section "Earth Moving" for excavating, backfilling, site grading, and for site utilities.
3. Division 31 Section "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.
4. Division 33 Section "Subdrainage" for permanent foundation wall, underfloor, and footing drainage.

1.3 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
1. Delegated Design: Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
3. Prevent surface water from entering excavations by grading, dikes, or other means.
4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
5. Remove dewatering system when no longer required for construction.

1.4 SUBMITTALS

A. Shop Drawings: For dewatering system. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.
1. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
2. Include a written plan for dewatering operations including control procedures to be adopted if dewatering problems arise.

B. Delegated-Design Submittal: For dewatering system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Qualification Data: For qualified Installer, land surveyor, and professional engineer.

D. Field quality-control reports.

E. Other Informational Submittals:
1. Photographs or Videotape: Show existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by dewatering operations.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer that has specialized in design of dewatering systems and dewatering work.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with hauling and disposal regulations of authorities having jurisdiction.

C. Preinstallation Conference: Conduct conference at Project site.
1. Review methods and procedures related to dewatering including, but not limited to, the following:
a. Inspection and discussion of condition of site to be dewatered including coordination with temporary erosion control measures and temporary controls and protections.
b. Geotechnical report.
c. Proposed site clearing and excavations.
d. Existing utilities and subsurface conditions.
e. Coordination for interruption, shutoff, capping, and continuation of utility services.
f. Construction schedule. Verify availability of Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
g. Testing and monitoring of dewatering system.

1.6 PROJECT CONDITIONS

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

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.
1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
2. The geotechnical report is included or referenced elsewhere in the Project Manual.

C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
   1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
   2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Provide temporary grading to facilitate dewatering and control of surface water.

D. Monitor dewatering systems continuously.

E. Promptly repair damages to adjacent facilities caused by dewatering.

F. Protect and maintain temporary erosion and sedimentation controls.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
   1. Space well points or wells at intervals required to provide sufficient dewatering.
   2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
   1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
   1. Maintain piezometric water level a minimum of 24 inches below surface of excavation.

E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids

inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

F. Provide standby equipment on site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.
   1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

3.3 FIELD QUALITY CONTROL

A. Observation Wells: Provide, take measurements, and maintain at least the minimum number of observation wells or piezometers indicated; additional observation wells may be required by authorities having jurisdiction.
   1. Observe and record daily elevation of ground water and piezometric water levels in observation wells.
   2. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. In areas where observation wells are not functioning properly, suspend construction activities until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
   3. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.

B. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.

END OF SECTION

SECTION 31 25 00

EROSION & SEDIMENTATION CONTROLS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Division 01 Section “Sustainable Design Requirements” for additional LEED requirements.

1.2 SUMMARY

A. Installation of temporary and permanent erosion control systems.

B. Installation of temporary and permanent slope protection systems.

1.3 ENVIRONMENTAL REQUIREMENTS

A. Protect adjacent properties and water resources from erosion and sediment damage throughout life of contract.

PART 2 PRODUCTS

2.1 MATERIALS

A. Quick growing grasses such as wheat, rye, or oats.

B. Fencing for siltation control as specified on Construction Drawings.

C. Curlex blankets by American Excelsior Company or approved equal.

D. Temporary mulches such as loose hay, straw, netting, wood cellulose, or agricultural silage.

E. Fence stakes shall be minimum of 5-ft in length and be either metal stakes or 2-inch x 2-inch hardwood stakes driven 1'-6" into ground.

PART 3 EXECUTION

3.1 PREPARATION

A. Review Construction Drawings and Storm Water Pollution Prevention Plan.

B. Conduct pre-construction meeting with Site Contractor.

3.2 EROSION CONTROL AND SLOPE PROTECTION IMPLEMENTATION

A. Place erosion control systems in accordance with Construction Drawings and Storm Water Pollution Prevention Plan or as may be dictated by site conditions in order to maintain the intent of the specifications and permits at no additional cost to Owner.

B. Deficiencies or changes on Construction Drawings or Storm Water Pollution Prevention Plan shall be implemented as site conditions change.

C. Owner has authority to limit surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and embankment operations and to direct Contractor to provide immediate permanent or temporary pollution control measures.

D. Maintain temporary erosion control systems as directed by Owner or governing authorities to control siltation during life of contract. Contractor shall respond to maintenance or additional work ordered by Owner or governing authorities within 48 hours or sooner if required at no additional cost to the Owner.

E. Contractor will be required to incorporate permanent erosion control features into project at earliest practical time to minimize need for temporary controls.

F. Permanently seed and mulch cut slopes as excavation proceeds to extent considered desirable and practical.

G. Slopes that erode easily or that will not be graded for a period of 14 days or more shall be temporarily seeded as work progresses with wheat, rye, or oats application, unless otherwise specified on the Construction Drawings.

END OF SECTION

SECTION 32 12 16

ASPHALT PAVING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Hot-mix asphalt patching.
2. Hot-mix asphalt paving.
3. Pavement-marking paint.

B. Related Sections:
1. Section 312000 "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.
2. Section 321373 "Concrete Paving Joint Sealants" for joint sealants and fillers at paving terminations.

1.3 DEFINITION

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

B. ODOT: Ohio Department of Transportation.

C. ODOT Item Number: Items are as specified in the State of Ohio Department of Transportation Construction and Materials Specifications, 2013 edition.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
1. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
2. Job-Mix Designs: For each job mix proposed for the Work.

B. LEED Submittals:
1. Product Data for Credit MR 4.1 and Credit MR 4.2 for LEED-NC: For products having recycled content documentation indicating percentages by weight of post-consumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content.
2. Product certificates for Credit MR 5.1 and Credit MR 5.2 for LEED-NC: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest or recovery for each raw material. Include statement indicating distance to project, cost for each regional material, and percentage by weight that is considered regional.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified manufacturer and Installer.

B. Material Certificates: For each paving material, from manufacturer.

C. Material Test Reports: For each paving material.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or ODOT.

B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of ODOT Item 448 for asphalt paving work.
1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

D. Preinstallation Conference: Conduct conference at Project site.
1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:
a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
b. Review condition of subgrade and preparatory work.
c. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
d. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
1. Tack Coat: Minimum surface temperature of 60 deg F.
2. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 55 deg Ffor water-based materials, and not exceeding 95 deg F.

PART 2 PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Provide aggregate as specified in ODOT Item 448.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a, PG 64-22.

B. Tack Coat: ODOT Item 407 emulsified asphalt, or cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

C. Water: Potable.

2.3 AUXILIARY MATERIALS

A. Sand: ASTM D 1073 or AASHTO M 29, Grade Nos. 2 or 3.

B. Joint Sealant: ODOT Item 705.04

C. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than 45 minutes.
1. Color: As selected by Owner.

D. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 4-1/2 inches high by 6 inches wide by 72 inches long. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.
1. Dowels: Galvanized steel, 3/4-inchdiameter, 30-inch minimum length.

2.4 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes per ODOT 448. See plans for types and thickness.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 20 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Project Geotechnical Engineer, and replace with compacted backfill or fill as directed.

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

D. Verify that utilities, traffic loop detectors, and other items requiring a cut and installation beneath the asphalt surface have been completed and that asphalt surface has been repaired flush with adjacent asphalt prior to beginning installation of imprinted asphalt.

3.2 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd.
1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

C. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.3 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.
1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.4 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at minimum temperature of 250 deg F.
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.5 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.6 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927 or AASHTO T 245, but not less than 94 percent nor greater than 100 percent.
2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.7 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
1. Surface Course: 1/8 inch.

3.8 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow paving to age for 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.9 WHEEL STOPS

A. Securely attach wheel stops to pavement with not less than two galvanized-steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.
1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

E. Replace and compact hot-mix asphalt where core tests were taken.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.11 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

END OF SECTION

SECTION 32 13 13

CONCRETE PAVING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Driveways.
2. Curbs.
3. Walks.
4. Detectable warning surface materials.

B. Related Sections:
1. Section 033000 "Cast-in-Place Concrete" for general building applications of concrete.
2. Section 321373 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

B. ODOT: Ohio Department of Transportation.

C. ODOT Item Number: Items are as specified in the State of Ohio Department of Transportation Construction Material Specifications, 2013 edition.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
1. Include installation and maintenance practices for detectable warning surface(s).

B. Shop Drawings: Provide installation procedures for detectable warning surface. Provide drawings showing unit placement including joints.

C. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.

D. Samples for Verification: For each type of product or exposed finish, prepared as Samples of size indicated below:
1. Detectable Warning Surface Materials: 6 inches by 6 inches of kind proposed for use.

E. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer of detectable warnings, ready-mix concrete manufacturer and testing agency.

B. Material Certificates: For the following, from manufacturer:
1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Admixtures.
4. Curing compounds.
5. Bonding agent or epoxy adhesive.
6. Joint fillers.

C. Material Test Reports: For each of the following; from a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:
1. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
2. Detectable warning surface materials.

D. Field quality-control reports.

E. Minutes of preinstallation conference.

1.6 DELIVERY, STORAGE AND HANDLING

A. Detectable Warning Surface products shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy wrappings. Products shall be identified by part number.

1.7 QUALITY ASSURANCE

A. Detectable Warning Surface Installer Qualifications: An employer of workers trained and approved by manufacturer of detectable warning surface materials who has completed installations similar in material, design and extent to that indicated for Project.

B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

C. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

D. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.

E. ACI Publications: Comply with ACI 301 unless otherwise indicated.

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
   1. Require representatives of each entity directly concerned with concrete paving to attend, including the following:
      a. Contractor's superintendent.
      b. Independent testing agency responsible for concrete design mixtures.
      c. Ready-mix concrete manufacturer.
      d. Concrete paving subcontractor.

1.8 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
   1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.

B. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

C. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

D. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60, deformed bars; assembled with clips.

E. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.

F. Deformed-Steel Wire: ASTM A 496/A 496M.

G. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.

H. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.

I. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

J. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:
1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

K. Zinc Repair Material: ASTM A 780.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:
1. Provide concrete materials per ODOT 452 and 608 except ground granulated blast furnace slag shall not be permitted.

2.4 CURING MATERIALS

A. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

2.5 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.

B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Epoxy Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:
1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.6 DETECTABLE WARNING MATS

A. Surface-Applied Detectable Warning Mats: Accessible truncated-dome detectable warning resilient mats, UV resistant, manufactured for adhering to existing concrete walkway surfaces, with slip-resistant surface treatment on domes, field of mat, and beveled outside edges.
1. Material: Modified rubber compound, UV resistant.
2. Color: As selected by Architect from manufacturer's full range.
3. Shapes and Sizes:
a. Rectangular panel, 24 by 36 inches.
4. Dome Spacing and Configuration: Manufacturer's standard compliant spacing, in manufacturer's standard pattern.
5. Mounting: Adhered to pavement surface with adhesive and fastened with fasteners.

2.7 CONCRETE MIXTURES

A. Provide Class QC1 concrete per ODOT 452 and 608 except ground granulated blast furnace slag shall not be permitted.

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ODOT 452 and 608. Furnish batch certificates for each batch discharged and used in the Work.
   1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ODOT 452 and 608. Mix concrete materials in appropriate drum-type batch machine mixer.
   1. For concrete batches of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
   2. For concrete batches larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
   3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
   1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
   2. Proof-roll with a pneumatic-tired and loaded, 20-wheel, tandem-axle dump truck weighing not less than 20 tons.
   3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 312000 "Earth Moving."

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

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.

F. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.5 JOINTS

A. General: Form construction, isolation, and control joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Provide tie bars at sides of paving strips where indicated.
3. Butt Joints: Use bonding agent or epoxy bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
4. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
1. Locate expansion joints at intervals of 50 feet unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.

6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Control Joints: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of the concrete thickness, as follows:
1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of control joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.
a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.
2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.
3. Doweled Control Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels and joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Curbs: Use design mixture for automatic machine placement. Produce curbs to required cross section, lines, grades, finish, and jointing.

K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

L. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

M. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.8 DETECTABLE WARNINGS

A. Install detectable warning units in wet concrete per manufacturer’s written instructions.

3.9 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

D. Curing Methods: Cure concrete by curing compound as follows:
1. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.10 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:
1. Elevation: 3/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot-long, unleveled straightedge not to exceed 1/2 inch.
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
5. Lateral Alignment and Spacing of Dowels: 1 inch.
6. Vertical Alignment of Dowels: 1/4 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
8. Joint Spacing: 3 inches.
9. Control Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.
a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.12 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 32 13 73

CONCRETE PAVING JOINT SEALANTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Expansion and contraction joints within cement concrete pavement.
2. Joints between cement concrete and asphalt pavement.

B. Related Sections:
1. Division 32 Section "Asphalt Paving" for constructing joints between concrete and asphalt pavement.
2. Division 32 Section "Concrete Paving" for constructing joints in concrete pavement.

1.3 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Verification: For each kind and color of joint sealant required. Provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of joint sealant and accessory, from manufacturer.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for joint sealants.

C. Preconstruction Compatibility and Adhesion Test Reports: From joint-sealant manufacturer, indicating the following:
1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility with and adhesion to joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Source Limitations: Obtain each type of joint sealant from single source from single manufacturer.

C. Product Testing: Test joint sealants using a qualified testing agency.
   1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

D. Preinstallation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:
   1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
   2. When joint substrates are wet.
   3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
   4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 PRODUCTS

2.1 MATERIALS

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Nonsag, Silicone Joint Sealant for Concrete: ASTM D 5893, Type NS.

B. Single-Component, Self-Leveling, Silicone Joint Sealant for Concrete: ASTM D 5893, Type SL.

C. Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant for Concrete: ASTM C 920, Type M, Grade P, Class 25, for Use T.

2.3 HOT-APPLIED JOINT SEALANTS

A. Hot-Applied, Single-Component Joint Sealant for Concrete and Asphalt: ASTM D 6690, Types I, II, and III.

2.4 JOINT-SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

D. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.5 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

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

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install joint-sealant backings of kind indicated to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of joint-sealant backings.
   2. Do not stretch, twist, puncture, or tear joint-sealant backings.
   3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place joint sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:
   1. Remove excess joint sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING

A. Clean off excess joint sealant or sealant smears adjacent to joints as the Work progresses, by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

END OF SECTION

SECTION 323119

DECORATIVE METAL FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Decorative steel tubular fence posts and swing gates with aluminum louver panels.

B. Related Sections:

1. Division 03 “Cast-in Place Concrete” for post concrete fill.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For gates. Include plans, elevations, sections, details, and attachments to other work.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code – Steel and AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

PART 2 - PRODUCTS

2.1 STEEL AND IRON

A. Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Tubing: ASTM A 500, cold formed steel tubing.

2.2 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

1. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for strength and compatibility in fabricated items.

B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Division 03 Section "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi, 3-inch slump, and 1-inch maximum aggregate size.

C. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107 and specifically recommended by manufacturer for exterior applications.

2.3 DECORATIVE STEEL FENCE AND GATES

A. Posts: Square steel tubing, hot-dip galvanized.

1. Swing Gate Posts: 6 by 6 inch with 1/8 inch wall thickness.

2. Fence Post: 4 by 4 inch with 1/8 inch wall thickness.
3. Post Caps: Formed from steel sheet, hot-dip galvanized after forming.

B. Decorative Steel Gates: Gates made from steel tubing and shapes; hot-dip galvanized.

1. Gate Configuration: Double leaf.

2. Gate Frame: Minimum 3 by 3 inch with 1/8 inch wall thickness.
3. Same aluminum louver infill panels as fence.

C. Hardware General: Equip gates with manufacturers standard hardware as required for complete functional operation.

D. Hinges: Amteco Heavy Duty Hinges.

1. Heavy duty brass bearing hinges, 3 per leaf.

E. Latch: 3/4 inch diameter slide bolt to accommodate padlock.

F. Cane Bolts: Provide for both leaves of pairs of gates.

1. Fabricated from 5/8" diameter, round steel bars, hot-dip galvanized after fabrication.
2. Provide galvanized steel pipe strikes to receive cane bolts in both open and closed positions.

   a. Closed strike to be Padlockable.

3. Provide galvanized steel pipe embedment sleeves in pavement for both gates in the open and closed position.
4. Finish to match gates.

G. Rolling Mechanism: Heavy duty caster wheel for each gate leaf.

H. Fasteners: Stainless-steel carriage bolts and nuts.

I. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay.

J. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A 123/A 123M. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.

1. Hot-dip galvanize posts and gate frame.

K. Finish for Steel Items: Shop Painted Polyester powder coating.

2.4 DECORATIVE STEEL LOUVER PANELS

A. Decorative Aluminum Louver Panel: Infill panels made from aluminum extrusions.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Shadow fixed louver pattern fence panels by Amteco Manufacturing Corporation.

B. Horizontal Fixed Louvers: Formed louver bars, 1-31/32 by 1/16 inch spaced at 1-13/36 inch. Direct louver flange for 100 percent direct visual screening.

1. Cross Rods: 5/32 inch diameter rods welded perpendicular to back side of louver bars spaced at 5-7/32 inches.

2. Perimeter Side Support Bars: 2 by 1/4 inch flat bars.
3. Panel Height and Width: As indicated.

C. Fasteners: Manufacturer's standard, corrosion-resistant, color-coated fasteners matching louver components welding louvers to framing bars.

D. Fabrication: Assemble panels by welding bars to aluminum framing.

E. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay.

F. Finish: Shop Painted Polyester powder coating.

2.5 STEEL FINISHES

A. Surface Preparation: Clean surfaces according to SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning."

1. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.

B. Steel fence panels and posts shall be hot-dip galvanized to 1.25 ounces per square foot minimum zinc coating in accordance with ASTM A123.

C. Polyester Powder Coating: Electrostatically applied colored polyester powder coating heat cured to chemically bond finish to metal substrate.

1. Color and Gloss: Match Architect's as selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

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

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

1. Construction layout and field engineering are specified in Division 01 Section "Execution"

3.3 DECORATIVE FENCE AND GATE INSTALLATION

A. Install according to manufacturer's written instructions.

B. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 24 inches plus 3 inches for each foot or fraction of a foot that fence height exceeds 4 feet.

C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

a. Exposed Concrete: Extend 1 inches above grade. Finish and slope top surface to drain water away from post.

3. Posts Set in Concrete: Extend post to within 6 inches of specified excavation depth, but not closer than 3 inches to bottom of concrete.

D. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.4 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire

operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

END OF SECTION

SECTION 32 92 00

LAWN - SEED

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Provisions of the Contract, including General and Supplementary General Conditions apply to the Work of this Section.

1.2 WORK OF THIS SECTION
A. Furnish all labor, materials and equipment to complete all work as herein specified and as indicated on the Drawings.

1.3 RELATED WORK
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications, apply to this Section.
B. The requirements of each of the following Contract Documents apply to the Work of this Section.
1. Section 31 22 19, Finished Grading
C. The following standards form a part of these specifications:
1. ODOT Specifications (Ohio Department of Transportation, Construction & Materials Specification):
Item 659

1.4 SUBMITTALS
A. Submit certified manufacturer and supplier data in compliance with Specifications for the following products:
1. Seed Mixes
2. Fertilizer
3. Lime
4. Erosion Control Fabric
5. Herbicides, pesticides and fungicides
6. Mulch

1.5 DELIVERY & STORAGE
A. Delivery - Deliver seeding products and materials to the site in the original, unopened containers bearing the manufacturer's warranted chemical analysis, name, trade name or trademark, and in conformance to state and federal law.
B. Storage - Keep seeding products and materials in dry storage away from contaminants and exposure to precipitation and runoff.

1.6 SEEDING SEASONS
A. Seed shall be sown only within the Fall season or the Spring season unless otherwise directed by the Landscape Architect.
B. Lawn Seed Mix Seeding Season: The Fall season shall be from the beginning of the first noticeable night dews until October 1st. The Spring season shall be from the time the ground is in suitable working condition until June 1st.
C. If final seed areas cannot be completed within the Fall or Spring seeding season, stabilize soil areas with an installation of nurse seed mix until final seeding can be installed during.

PART 2 -PRODUCTS

2.1 SEED

A. Seed shall be composed of the required varieties which shall be mixed in the proportions and shall test the minimum percentages of purity and germination specified.

B. Seed shall be fresh, clean, new crop seed, dealer mixed. The Contractor shall furnish to the Architect the manufacturer's guaranteed statement with the complete composition of the mixtures and the percentages of purity and germination of each variety. Certified analysis shall be delivered to the Architect before use.

C. Lawn Seed Mix – Oliger Seed Company – 'Fairlawn Brand' Seed Mix (or approved equal).

Name	Proportion by Weight	Percent of Purity	Percent Germination
Kentucky Bluegrass	35%	98%	90%
Brooklyn Kentucky Bluegrass	10%	98%	80%
Edgewood Creeping Red Fescue	15%	98%	90%
Perennial Rye Grass – Paragon GLR, Amazing GS, Fiesta 4 and Homerun	40%	98%	90%

Seed at rate of 7 pounds per 1000 s.f. (if applied by hydroseeding – seed at 8 lbs. per 1000 s.f.)

a. Maximum weed content 0.10%.
b. Spring or fall seeding.

2.2 LIME

A. Lime shall be agricultural limestone containing not less than 90 percent calcium and magnesium carbonates. Lime must be ground to such a fineness that not less than 90% must pass No. 8 mesh and not less than 25% must pass No. 100 mesh. Moisture is not to exceed 10%.

B. Use lime to correct any excess acidity in amount determined by the soil test.

2.3 FERTILIZER

A. Provide turf fertilizer that is commercial grade, free flowing, uniform in composition, and conforms to applicable state and federal regulations. Granular fertilizer shall bear the manufacturer's warranted statement of analysis. Granular fertilizer shall contain a minimum percentage by weight of 10% of Nitrogen (of which a minimum of 50%, in approved slow release form); 6% of Phosphoric Acid; 4% of Potash. Liquid starter fertilizer for use in the hydro seed slurry will be commercial type with 50 percent of the nitrogen in slow release form.

B. Fertilizer shall be spread evenly over the area at the rate of 25 pounds per 1,000 square feet.

C. Fertilizer formulation shall be adjusted as directed by the Landscape Architect to meet requirements for lawns if soil test results so indicate.

2.4 MULCH

A. Mulch shall be free from deleterious materials and shall be stored as to prevent inclusion of foreign material.

B. Straw for lawn seed bed mulch shall be stalks from oats that are free from noxious weeds, mold or other objectionable material. Straw shall be in an air-dry condition and suitable for placing with blower equipment.

1. Spread straw mulch over prepared seed bed areas at a rate of 2000 pounds per acre.

C. Wood cellulose fiber for use with hydraulic application of grass seed and fertilizer shall consist of specially prepared wood cellulose fiber, processed to contain no growth or germination-inhibiting factors, and dyed an appropriate color to facilitate visual metering of the application of materials. On an air-dry weight basis, the wood cellulose fiber shall contain a maximum of 12 percent moisture, plus or minus three percent at the time of manufacture. The pH range shall be from 3.5 to 5.0. The wood cellulose fiber shall be manufactured so that:
   1. After addition and agitation in slurry tanks with fertilizers, grass seeds, water, and other approved additives, the fibers in the material will become uniformly suspended to form a homogeneous slurry.
   2. When hydraulically sprayed on the ground, the material will form a blotter like cover impregnated uniformly with grass seed.
   3. The cover will allow the absorption of moisture and allow rainfall or applied water to percolate to the underlaying soil.

2.5 TOPSOIL

A. See Section 31 22 19, Finished Grading for topsoil requirements.

2.6 EROSION CONTROL FABRIC

A Sloped grades 3:1 and greater – Jute burlap, unbleached and undyed; woven mesh; 0.92 lbs./sy; 50%-60% open area; yarn count: 78 per width warp direction and 42 per width weft direction. Submit product information for approval.

B. Vegetated swales and channels – biodegradable double net erosion control blanket. Blanket shall be machine produced mat of 70% agricultural straw and 30% coconut fiber sandwiched between layers of biodegradable net on top and bottom. Blanket shall have a functional longevity of 18 months. The blanket shall be sewn together on 1.50 inch centers with biodegradable threads. Submit product information for approval. Material content of blanket shall be as follows:
   1. 70% straw fiber (0.5 lbs per sy)
   2. 30% coconut fiber (0,15 lbs per sy)
   3. Jute netting (9.3 lbs per 1000 sf)
   4. Thickness - ASTM D6525 (0.28 in)
   5. Water absorbency – ASTM D1117 (169%)
   6. Mass – ASTM 6475 (9.66 oz per sy)
   7. Light Penetration – ECTC guidelines (14.1%)
   8. Tensile strength TD – ASTM D6818 (226.8 lbs/ft)

PART 3 - EXECUTION

3.1 PREPARATION OF SEED BED

A. After the areas to be seeded have been brought to the approximate finished surface grade by the use of the existing or hauled in topsoil, they shall be fine graded. All small areas or those adjacent to the trees, planted areas, buildings, walks or other structures shall be fine graded by hand tools, but larger areas may be fine graded by mechanical devices if done in a manner acceptable to the Architect. .

B. Remove stones and clumps (1 inch or larger in any dimension), sticks, roots, vegetation and other extraneous materials prior to sowing of seed.

C. No fine grading shall be done when the soil is frozen or muddy. Do not overwork the soil. After rain, the seed bed shall be re-prepared for sowing and repeated after each rain until lawn is completed

E. Apply fertilizer and lime at rates determined by soil testing results and recommendations, and as directed by the Landscape Architect. Incorporate fertilizers and lime into the soil to a depth of at least 4 inches as part of the finish grading operation. Immediately restore the soil to an even condition before any turf work.

3.2 SOWING OF SEED

A. Sowing: Seed shall be sown in accordance with rates that are indicated in Item 2.1.
   1. On small areas when using a drop or cyclone spreader, the seed shall be divided into two successive sowings, using 50% by weight for each sowing. The second sowing shall be at right angles to the direction of the first sowing. Rake in lightly to mix the seed into the surface of the soil; moisten with a fine spray.
   2. On medium sized areas, the Contractor may drill the seed into the soil in two operations at right angles to each other; moisten with a fine spray.
   3. Mulch: Immediately after preparing the seed bed area, evenly spread an organic mulch of straw by hand or by approved mechanical blowers at the rate of 2,000 per acre. Application shall allow some sunlight to penetrate and air to circulate but also reduce soil and seed erosion and conserve soil moisture. Anchor mulch with netting. Contractor must provide install netting in all seeded areas where using straw.

B. Hydroseeding: Hydroseeding is acceptable on large areas. The hydroseeding slurry shall contain the seed, mulch, dyed green, tackifier, fertilizer and lime as required by the by topsoil testing results and recommendations..
   1. When hydroseeding, mix the seed and slow release starter fertilizer, or the seed, fertilizer, lime when required and approved wood cellulose mulch material in the required amount of water to produce a homogeneous slurry and then uniformly apply slurry under pressure.
   2. When using wood cellulose mulch, incorporate it as an integral part of the slurry mix after the seed and fertilizer have been thoroughly mixed. Mulch using 10% of the mulching material with the seeding to ensure optimal seed/soil contact. The balance of the mulch shall be applied separately as a second step.

C. Re-seeding:
   1. All seeded areas which do not show a satisfactory catch of the specified plants shall be re-seeded as herein specified at intervals of 21 days, until a satisfactory turf is established.

3.3 MAINTENANCE

A. Maintenance shall begin immediately after each area is seeded, and shall continue in accordance with the following requirements:
   1. General
      a. Seeded areas shall be protected against damage and erosion. Proper safeguards and protection to seed areas shall be provided. Damaged areas shall be promptly replanted.
         Growth of seeded areas shall be maintained by watering, weeding, replanting, rolling, mowing, trimming and other operations as necessary to establish a uniformly thick and well developed stand of specified seeded plants that are reasonably free of weeds and undesirable coarse turf type grasses.
      b. Any trenched area that settles below finished grade shall be refilled with topsoil and re-seeded as directed by the Landscape Architect.
      c. The Contractor will immediately replace any areas void of healthy seeded vegetation.
      d. Control weed growth through mowing
      e. The Contractor shall provide new applications of specified seed to any areas that are found to display unacceptable areas of plant coverage and until coverage reaches compliance with specified requirements.
   2. Lawn
      a. Lawns shall be mowed whenever grass becomes 3 1/2" high and maintained at 2 1/2" height. Lawns shall be maintained for a minimum of two months beyond initial lawn establishment and as much longer as necessary to establish over the entire lawn areas a close stand of grasses as specified and reasonably free of weeds and undesirable coarse native grasses. Scattered bare spots, none larger than one-fourth square foot in

area, will be allowed up to 3% of any contiguous lawn area

b. Any trenched area that settles below finished grade shall be refilled with topsoil and re-seeded or sodded as directed by the Architect.

c. At end of maintenance, fertilize all lawn areas, same rate as original application, applying in Fall for Spring planted lawns, not any later than October 1st, in Spring for Fall planted lawns, not any later than June 15th.

3.4 PROTECTION OF WORK AND CLEAN-UP OF SITE

A. Immediately after installation of seeded areas, protect against traffic or other use by erecting barricades, as required, and placing approved signs at appropriate intervals until final acceptance.

B. The Contractor shall remove from the site all excess soil, cordage, wrappings and other extraneous material. Remove all tools, equipment and other material, except those necessary for maintenance. Litter, including lawn clippings, developed by reason of the Contractor's maintenance shall be removed as it gathers.

3.5 FINAL INSPECTION

A. Inspection of seeded areas will be made at conclusion of maintenance after our receipt of written request for inspection from the Contractor.

B. Upon the completion of all work in this Section, including maintenance, the work of seeded areas will be accepted by the Landscape Architect following final inspection of acceptable stand of specified plants.

END OF SECTION

SECTION 33 05 00

COMMON WORK RESULTS FOR UTILITIES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
1. Piping joining materials.
2. Transition fittings.

1.3 DEFINITIONS

A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.

B. Concealed Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

C. ABS: Acrylonitrile-butadiene-styrene plastic.

D. CPVC: Chlorinated polyvinyl chloride plastic.

E. PE: Polyethylene plastic.

F. PVC: Polyvinyl chloride plastic.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

PART 2 PRODUCTS

2.1 PIPING JOINING MATERIALS

A. Solvent Cements for Joining Plastic Piping:
1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

B. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.2 TRANSITION FITTINGS

A. Transition Fittings, General: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

B. Transition Couplings NPS 1-1/2 and Smaller:
1. Underground Piping: Manufactured piping coupling or specified piping system fitting.
2. Aboveground Piping: Specified piping system fitting.

C. AWWA Transition Couplings NPS 2 and Larger:
1. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.

D. Plastic-to-Metal Transition Fittings:
1. Description: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

E. Plastic-to-Metal Transition Unions:
1. Description: MSS SP-107, CPVC and PVC four-part union. Include brass or stainless-steel threaded end, solvent-cement-joint or threaded plastic end, rubber O-ring, and union nut.

F. Flexible Transition Couplings for Underground Non-pressure Drainage Piping:
1. Description: ASTM C 1173 with elastomeric sleeve ends same size as piping to be joined, and corrosion-resistant metal band on each end.

PART 3 EXECUTION

3.1 PIPING INSTALLATION

A. Install piping according to the following requirements and utility sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping to permit valve servicing.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Sleeves are not required for core-drilled holes.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 33 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendixes.
3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
5. PVC Nonpressure Piping: Join according to ASTM D 2855.
6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

F. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

G. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.

H. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
1. Plain-End PE Pipe and Fittings: Use butt fusion.
2. Plain-End PE Pipe and Socket Fittings: Use socket fusion.

I. Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

END OF SECTION

SECTION 33 10 00

FACILITY WATER DISTRIBUTION PIPING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes water-distribution piping and related components outside the building for water service, fire-service mains and combined water service and fire-service mains.

B. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

1.2 DEFINITIONS

A. EPDM: Ethylene propylene diene terpolymer rubber.

B. LLDPE: Linear, low-density polyethylene plastic.

C. PA: Polyamide (nylon) plastic.

D. PE: Polyethylene plastic.

E. PP: Polypropylene plastic.

F. PVC: Polyvinyl chloride plastic.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

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

C. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:
1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

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

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

D. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

E. NSF Compliance:
1. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
1. Ensure that valves are dry and internally protected against rust and corrosion.
2. Protect valves against damage to threaded ends and flange faces.
3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves, including fire hydrants, according to the following:
1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.6 PROJECT CONDITIONS

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

1.7 COORDINATION

A. Coordinate connection to water main with utility company.

PART 2 PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper.
1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.

2.2 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Gaskets: AWWA C111, rubber.

C. Flanges: ASME 16.1, Class 125, cast iron.

2.3 PIPING SPECIALTIES

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

B. Tubular-Sleeve Pipe Couplings:
1. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.
a. Standard: AWWA C219.
b. Center-Sleeve Material: Ductile iron.
c. Gasket Material: Natural or synthetic rubber.
d. Pressure Rating: 200 psig minimum.
e. Metal Component Finish: Corrosion-resistant coating or material.

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

2.4 CORROSION-PROTECTION PIPING ENCASEMENT

A. Encasement for Underground Metal Piping:

1. Standards: ASTM A 674 or AWWA C105.
2. Form: Sheet or tube.
3. Material: LLDPE film of 0.008-inch minimum thickness, or high-density, cross-laminated PE film of 0.004-inch minimum thickness.
4. Color: Black or Natural.

2.5 GATE VALVES

A. AWWA, Cast-Iron Gate Valves:
   1. Non-rising-Stem, Resilient-Seated Gate Valves:
      a. Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
         1) Standard: AWWA C509.
         2) Minimum Pressure Rating: 200 psig.
         3) End Connections: Mechanical joint.
         4) Interior Coating: Complying with AWWA C550.

2.6 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:
   1. Description: Sleeve and valve compatible with drilling machine.
      a. Standard: MSS SP-60.
      b. Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
      c. Valve: AWWA, cast-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.

B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.
   1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

2.7 CHECK VALVES

A. AWWA Check Valves:
   1. Description: Swing-check type with resilient seat. Include interior coating according to AWWA C550 and ends to match piping.
      a. Standard: AWWA C508.
      b. Pressure Rating: 175 psig.

2.8 CORPORATION VALVES AND CURB VALVES

A. Service-Saddle Assemblies: Comply with AWWA C800. Include saddle and valve compatible with tapping machine.
   1. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
   2. Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.
   3. Manifold: Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.

B. Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.

C. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches in diameter.
   1. Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

2.9 WATER METERS

A. Water meters will be furnished by utility company, unless noted otherwise.

2.10 FIRE HYDRANTS

A. Dry-Barrel Fire Hydrants (confirm with fire department)
   1. Description: Freestanding, with one NPS 4-1/2 and two NPS 2-1/2 outlets, 5-1/4-inch main valve, drain valve, and NPS 6 mechanical-joint inlet. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure. (Confirm with fire department.)
      a. Standards: UL 246, FMG approved.
      b. Pressure Rating: 250 psig.
      c. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
      d. Operating and Cap Nuts: Pentagon, 1-1/2 inches point to flat.
      e. Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.
      f. Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.

B. Wet-Barrel Fire Hydrants (confirm with fire department)
   1. Description: Freestanding, with one NPS 4-1/2 and two NPS 2-1/2 outlets, NPS 6 threaded or flanged inlet, and base section with NPS 6 mechanical-joint inlet. Include interior coating according to AWWA C550.
      a. Standard: AWWA C503.
      b. Pressure Rating: 150 psig minimum.
   2. Description: Freestanding, with one NPS 4-1/2 and two NPS 2-1/2 outlets, NPS 6 threaded or flanged inlet, and base section with NPS 6 mechanical-joint inlet.
      a. Standards: UL 246 and FMG approved.
      b. Pressure Rating: 150 psig minimum.
      c. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
      d. Operating and Cap Nuts: Pentagon, 1-1/2 inches point to flat.
      e. Direction of Opening: Open hydrant valves by turning operating nut to left or counterclockwise.
      f. Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.

PART 3 EXECUTION

3.1 EARTHWORK

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.

B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.

C. Do not use flanges or unions for underground piping.

D. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

E. Underground water-service piping NPS 3/4 to NPS 3 shall be the following:
1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.

F. Underground water-service piping NPS 4 to NPS 8 shall be the following:
1. Ductile-iron, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.

G. Underground Fire-Service-Main Piping NPS 4 to NPS 12 shall be the following:
1. Ductile-iron, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.

H. Above ground and Vault Fire-Service-Main Piping NPS 4 to NPS 12 shall be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.

I. Underground Combined Water-Service and Fire-Service-Main Piping NPS 6 to NPS 12 shall be the following:
1. Ductile-iron, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.

3.3 VALVE APPLICATIONS

A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, non-rising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.

B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Underground Valves, NPS 3 and Larger: AWWA, cast-iron, nonrising-stem, resilient-seated gate valves with valve box.
2. Use the following for valves in vaults and aboveground:
   a. Gate Valves, NPS 2 and Smaller: Bronze, non-rising stem.
   b. Gate Valves, NPS 3 and Larger: AWWA, cast iron, OS&Y rising stem, resilient seated.
   c. Check Valves: AWWA C508, swing type.
3. Relief Valves: Use for water-service piping in vaults and aboveground.
   a. Air-Release Valves: To release accumulated air.
   b. Air/Vacuum Valves: To release or admit large volume of air during filling of piping.
   c. Combination Air Valves: To release or admit air.
4. Detector Check Valves: Use for water-service piping in vaults and aboveground to detect unauthorized use of water.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

A. See Division 22 Section "Common Work Results for Plumbing" for piping-system common requirements.

3.5 PIPING INSTALLATION

A. Water-Main Connection: Arrange with utility company for tap of size and in location indicated in water main.

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

C. Comply with NFPA 24 for fire-service-main piping materials and installation.
1. Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.
2. Install copper tube and fittings according to CDA's "Copper Tube Handbook."

D. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
1. Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.

E. Bury piping with depth of cover over top at least 60 inches, with top at least 12 inches below level of maximum frost penetration.

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

G. Sleeves are specified in Division 22 Section "Common Work Results for Plumbing."

H. Mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."

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

J. See Division 21 Section "Water-Based Fire-Suppression Systems" for fire-suppression-water piping inside the building.

K. See Division 22 Section "Domestic Water Piping" for potable-water piping inside the building.

3.6 JOINT CONSTRUCTION

A. See Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.

B. Make pipe joints according to the following:
1. Copper-Tubing, Pressure-Sealed Joints: Use proprietary crimping tool and procedure recommended by copper, pressure-seal-fitting manufacturer.
2. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
3. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
4. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure. Refer to Division 22 Section "Common Work Results for Plumbing" for joining piping of dissimilar metals.

3.7 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
1. Concrete thrust blocks.
2. Locking mechanical joints.
3. Set-screw mechanical retainer glands.
4. Bolted flanged joints.
5. Heat-fused joints.
6. Pipe clamps and tie rods.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
2. Bonded-Joint Fiberglass, Water-Service Piping: According to AWWA M45.
3. Fire-Service-Main Piping: According to NFPA 24.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.8 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.

C. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.

D. UL/FMG, Valves Other Than Gate Valves: Comply with NFPA 24.

E. MSS Valves: Install as component of connected piping system.

F. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

3.9 FIRE HYDRANT INSTALLATION

A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.

B. Wet-Barrel Fire Hydrants: Install with valve below frost line. Provide for drainage.

C. UL/FMG Fire Hydrants: Comply with NFPA 24.

3.10 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. See Division 22 Section "Common Work Results for Plumbing" for piping connections to valves and equipment.

C. Connect water-distribution piping to existing water main. Use tapping sleeve and tapping valve.

D. Connect water-distribution piping to interior domestic water and fire-suppression piping.

E. Connect waste piping from concrete vault drains to storm-drainage system. See Division 33 Section "Storm Utility Drainage Piping" for connection to storm-sewer piping.

F. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.11 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.
   1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig. Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

C. Prepare reports of testing activities.

3.12 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Division 31 Section "Earth Moving."

B. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel. See Division 22 Section "Common Work Results for Plumbing" for identifying devices.

3.13 CLEANING

A. Clean and disinfect water-distribution piping as follows:
   1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
   2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
   3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
      a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
      b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
      c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.

d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION

SECTION 33 30 00

FACILITY SANITARY SEWERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes gravity-flow, nonpressure sanitary sewerage outside the building, with the following components:
1. Precast concrete manholes.

1.3 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water.

B. All requirements and regulations of the Cuyahoga County Department of Public Works shall apply, unless a more stringent requirement is provide in the Drawings, Contract, or this Section.

1.5 SUBMITTALS

A. Product Data: For the following:
1. Special pipe fittings.

B. Shop Drawings: For the following:
1. Manholes: Include plans, elevations, sections, details, and frames and covers.

C. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewerage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

D. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1-inch equals 50 feet and vertical scale of not less than 1-inch equals 5 feet. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

E. Field quality-control test reports.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

1.7 PROJECT CONDITIONS

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

PART 2 PRODUCTS

2.1 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.

2.2 DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS

A. Pipe: ASTM A 746, for push-on joints.

B. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.

C. Compact Fittings: AWWA C153, for push-on joints.

D. Gaskets: AWWA C111, rubber.

2.3 PVC PIPE AND FITTINGS

A. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

B. PVC Sewer Pipe and Fittings, NPS 18 and Larger: ASTM F 679, T-1 wall thickness, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

C. PVC Profile Gravity Sewer Pipe and Fittings: ASTM F 794 pipe, with bell-and-spigot ends; ASTM D 3034 fittings, with bell ends; and ASTM F 477, elastomeric seals.

2.4 NONPRESSURE-TYPE PIPE COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Unshielded, Flexible Couplings: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

C. Shielded, Flexible Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Ring-Type, Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

E. Nonpressure-Type, Rigid Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.5 MANHOLES

A. Standard Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
1. Diameter: 48 inches minimum, unless otherwise indicated.
2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
3. Base Section: 6-inch minimum thickness for floor slab and 5-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
4. Riser Sections: 5-inch minimum thickness, and of length to provide depth indicated.
5. Top Section: Eccentric-cone type, unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
6. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
7. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
8. Steps: ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
9. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and diameter matching manhole frame and cover. Include sealant recommended by ring manufacturer.
10. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
11. Protective Coating: Plant-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 10-mil minimum thickness applied to exterior and interior surfaces.
12. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch-diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
    a. Material: ASTM A 536, Grade 60-40-18 ductile iron, unless otherwise indicated.
    b. Protective Coating: Foundry-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 10-mil minimum thickness applied to all surfaces, unless otherwise indicated.

2.6 CONCRETE

A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000-psi minimum, with 0.45 maximum water/cementitious materials ratio.
1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000-psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
   a. Invert Slope: 1 percent through manhole.
2. Benches: Concrete, sloped to drain into channel.
   a. Slope: 4 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000-psi minimum, with 0.58 maximum water/cementitious materials ratio.
1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

2.7 MISCELLANEOUS MATERIALS

A. Paint: SSPC-Paint 16.

PART 3 EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING APPLICATIONS

A. Pipe couplings and special pipe fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.
   a. Unshielded flexible couplings for same or minor difference OD pipes.
   b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
   c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
2. Use pressure-type pipe couplings for force-main joints.

B. Gravity-Flow, Non-pressure Sewer Piping: Use any of the following pipe materials for each size range:
1. NPS 6: PVC sewer pipe and fittings, gaskets, and gasketed joints.
2. NPS 6: Ductile-iron, gravity sewer pipe or NPS 4 ductile-iron pressure pipe; ductile-iron standard or compact fittings; gaskets; and gasketed joints.

3.3 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or combination of both.

F. Install gravity-flow, nonpressure, drainage piping according to the following:
1. Install piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.
2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
3. Install piping with 36-inch minimum cover.
4. Install piping below frost line.
5. Install ductile-iron, gravity sewer piping according to ASTM A 746.
6. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
7. Install PVC profile gravity sewer piping according to ASTM D 2321 and ASTM F 1668.

G. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.4 PIPE JOINT CONSTRUCTION

A. Basic piping joint construction is specified in Division 22 Section "Common Work Results for Plumbing" Where specific joint construction is not indicated, follow piping manufacturer's written instructions.

B. Join gravity-flow, nonpressure, drainage piping according to the following:
1. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
2. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
3. Join PVC profile gravity sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
4. Join dissimilar pipe materials with nonpressure-type, flexible couplings.

3.5 MANHOLE INSTALLATION

A. General: Install manholes complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Construct cast-in-place manholes as indicated.

D. Form continuous concrete channels and benches between inlets and outlet.

E. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere, unless otherwise indicated.

F. Install manhole cover inserts in frame and immediately below cover.

3.6 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318/318R.

3.7 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 22 Section "Sanitary Waste and Vent Piping."

B. Make connections to existing piping and underground manholes.
1. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
2. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.8 PAINTING

A. Clean and prepare concrete manhole surfaces for field painting. Remove loose efflorescence, chalk, dust, grease, oils, and release agents. Roughen surface as required to remove glaze. Paint the following concrete surfaces as recommended by paint manufacturer:
1. Precast Concrete Manholes: All exterior and interior.

B. Prepare ferrous frame and cover surfaces according to SSPC-PA 1 and paint according to SSPC-PA 1 and SSPC-Paint 16. Do not paint surfaces with foundry-applied corrosion-resistant coating.

3.9 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.
1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.10 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:
a. Alignment: Less than full diameter of inside of pipe is visible between structures.
b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 95 percent of piping diameter.
c. Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.
3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.

5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
   a. Allowable leakage is maximum of 50 gal./inch of nominal pipe size per mile of pipe, during 24-hour period.
   b. Close openings in system and fill with water.
   c. Purge air and refill with water.
   d. Disconnect water supply.
   e. Test and inspect joints for leaks.
   f. Option: Test ductile-iron piping according to AWWA C600, "Hydrostatic Testing" Section. Use test pressure of at least 10 psig.
6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
   a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
   b. Option: Test concrete gravity sewer piping according to ASTM C 924.
7. Manholes: Perform hydraulic test according to ASTM C 969.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.11 CLEANING

A. Clean interior of piping of dirt and superfluous material. Flush with potable water.

END OF SECTION

SECTION 33 41 00

STORM UTILITY DRAINAGE PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes gravity-flow, non-pressure storm drainage outside the building, with the following components:
   1. Cleanouts.
   2. Precast concrete manholes.
   3. Yard inlets.
   4. Precast concrete catch basins.

1.3 DEFINITIONS

A. HDPE: High Density Polyethylene plastic.

B. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Non-pressure, Drainage-Piping Pressure Rating: 10-foot head of water. Pipe joints shall be at least silttight, unless otherwise indicated.

1.5 SUBMITTALS

A. Shop Drawings: For the following:
   1. Manholes: Include plans, elevations, sections, details, and frames and covers.
   2. Catch Basins. Include plans, elevations, sections, details, and frames, covers, and grates.
   3. Yard Inlets: Include plans, elevations, sections, details and frames, covers and grates.
   4. Trench Drains: Include plans, elevations, sections, details, and frames, covers, and grates.

B. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

C. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1-inch equals 50 feet and vertical scale of not less than 1-inch equals 5 feet. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

D. Field quality-control test reports.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

D. Handle catch basins according to manufacturer's written rigging instructions.

1.7 PROJECT CONDITIONS

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

PART 2 PRODUCTS

2.1 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.

2.2 HDPE PIPE AND FITTINGS

A. Corrugated HDPE Drainage Pipe and Fittings NPS 10 and Smaller: AASHTO M 252M, Type S, with smooth waterway for coupling joints.
1. Silttight Couplings: HDPE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.

B. Corrugated HDPE Pipe and Fittings NPS 12 to NPS 48: AASHTO M 294M, Type S, with smooth waterway for coupling joints.
1. Silttight Couplings: HDPE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.

2.3 PVC PIPE AND FITTINGS

A. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

B. PVC Sewer Pipe and Fittings, NPS 18 and Larger: ASTM F 679, T- 2 wall thickness, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

C. PVC Profile Gravity Sewer Pipe and Fittings: ASTM F 794 pipe, with bell-and-spigot ends; ASTM D 3034 fittings, with bell ends; and ASTM F 477, elastomeric seals.

2.4 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76, with bell-and-spigot or groove and tongue ends and gasketed joints with ASTM C 443, rubber gaskets.
1. Class III, Wall C.

2.5 NON-PRESSURE-TYPE PIPE COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground non-pressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
1. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
2. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded Flexible Couplings: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded Flexible Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

F. Non-pressure-Type Rigid Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling modeled from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.6 CLEANOUTS

A. Gray-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
1. Top-Loading Classification(s): Heavy duty.
2. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.7 CONCRETE

A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000-psi minimum, with 0.45 maximum water-cementitious materials ratio.
1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.

C. Ballast and Pipe Supports: Portland cement design mix, 3000-psi minimum, with 0.58 maximum water-cementitious materials ratio.
1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.

2.8 MANHOLES

A. Standard Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
1. Diameter: 48 inches minimum, unless otherwise indicated.
2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
3. Base Section: 6-inch minimum thickness for floor slab and 5-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
4. Riser Sections: 5-inch minimum thickness and lengths to provide depth indicated.
5. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
6. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
7. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
8. Steps: ASTM A 615, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP,, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
9. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
10. Protective Coating: Plant-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 10-mil minimum thickness applied to exterior and interior surfaces.
11. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch- minimum width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
    a. Material: ASTM A 536, Grade 60-40-18 ductile iron, unless otherwise indicated.
    b. Protective Coating: Foundry-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 10-mil minimum thickness applied to all surfaces, unless otherwise indicated.

2.9 CATCH BASINS

A. Standard Precast Concrete Catch Basins: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
1. Base Section: 6-inch minimum thickness for floor slab and 5-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
2. Riser Sections: 5-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.
3. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
4. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
5. Grade Rings: Include 2 or 3 reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and grate.
6. Steps: ASTM A 615, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP,, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 60 inches.
7. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

B. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.

1. Size: 24 by 24 inches minimum, unless otherwise indicated.
2. Grate Free Area: Approximately 50 percent, unless otherwise indicated.

2.10 STORMWATER INLETS

A. Combination Inlets: Made with vertical curb and horizontal gutter openings, of materials and dimensions according to utility standards. Include heavy-duty frames and grates.

B. Frames and Grates: Heavy-duty frames and grates according to utility standards.

2.11 YARD INLETS

A. PVC surface drainage inlets shall include the drain basin type as indicated on the contract drawing. The ductile iron grates for each of these fittings are to be considered an integral part of the surface drainage inlet and shall be furnished by the same manufacturer.
1. The drain basins required for this contract shall be manufactured from PVC pipe stock, utilizing a thermo-molding process to reform the pipe stock to the specified configuration. The drainage pipe connection stubs shall be manufactured from PVC pipe stock and formed to provide a watertight connection with the specified pipe system. This joint tightness shall conform to ASTM D 3212 for joints for drain and sewer plastic pipe using flexible elastomeric seals. The pipe bell spigot shall meet the mechanical property requirements for fabricated fittings as described by ASTM D 3034, Standard for Sewer PVC Pipe and Fittings; ASTM F 1336, Standard for PVC Gasketed Sewer Fittings.
2. The grates furnished for all surface drainage inlets shall be ductile iron grates and shall be made specifically for each basin so as to provide a round bottom flange that closely matches the diameter of the surface drainage inlet. Grates for drain basins shall be capable of supporting H-20 wheel loading for heavy-duty traffic or H-10 loading for pedestrian traffic. Metal used in the manufacture of the castings shall conform to ASTM A 536 grade 70-50-05 for ductile iron and grates shall be provided painted black.

2.12 TRENCH DRAINS
1. Cast Iron Trench Drains:
a. Description: ASME A112.6.3, 6-inch-wide top surface, rectangular body with anchor flange or other anchoring device, and rectangular grate. Include units of total length indicated and quantity of bottom outlets with inside calk or spigot connections, of sizes indicated.
b. Top-Loading Classification(s): Heavy Duty

2.13 MISCELLANEOUS MATERIALS

A. Paint: SSPC-Paint 16.

PART 3 EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING APPLICATIONS

A. Pipe couplings and special pipe fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.

1. Use non-pressure-type flexible couplings where required to join gravity-flow, non-pressure sewer piping, unless otherwise indicated.
   a. Unshielded flexible couplings for same or minor difference OD pipes.
   b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
   c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

B. Gravity-Flow, Non-pressure Sewer Piping: Use any of the following pipe materials for each size range:
1. NPS 4 to 18: PVC sewer pipe and fittings; gaskets; and gasketed joints.
2. NPS 4 to 18: Corrugated PE drainage pipe and fittings, silttight couplings, and coupled joints.
3. NPS 8 to NPS 18: PVC profile gravity sewer pipe and fittings, gaskets, and gasketed joints.

3.3 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or a combination of both.

F. Install gravity-flow, non-pressure drainage piping according to the following:
1. Install piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.
2. Install piping NPS 6and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
3. Install piping with 36-inch minimum cover.
4. Install piping below frost line.
5. Install HDPE corrugated sewer piping according to CPPA's "Recommended Installation Practices for Corrugated Polyethylene Pipe and Fittings."
6. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
7. Install PVC profile gravity sewer piping according to ASTM D 2321 and ASTM F 1668.

3.4 PIPE JOINT CONSTRUCTION

A. Basic pipe joint construction is specified in Division 33 Section "Common Work Results for Utilities." Where specific joint construction is not indicated, follow piping manufacturer's written instructions.

B. Join gravity-flow, non-pressure drainage piping according to the following:
1. Join corrugated HDPE piping according to CPPA 100 and the following:

a. Use silttight couplings for Type 1, silttight joints.

2. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric gasket joints.
3. Join PVC profile gravity sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
4. Join dissimilar pipe materials with non-pressure-type flexible couplings.

C. Join dissimilar pipe materials with pressure-type couplings.

3.5 CLEANOUT INSTALLATION

A. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
1. Use light-duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
2. Use medium-duty, top-loading classification cleanouts in paved foot-traffic areas.
3. Use heavy-duty, top-loading classification cleanouts in vehicle-traffic service areas.

B. Set cleanout frames and covers in earth. Set with tops 1 inch below surrounding earth grade.

C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.6 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections according to ASTM C 891.

C. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere, unless otherwise indicated.

3.7 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.8 YARD INLET INSTALLATION

A. The Specified PVC surface drainage inlet shall be installed using conventional flexible pipe backfill materials and procedures. The backfill material shall be crushed stone or other granular material meeting the requirements of class 1 or 2 material as defined in ASTM D 2321. The surface drainage inlets shall be bedded and back-filled uniformly in accordance with ASTM D 2321. The drain basin body will be out at the time of the final grade so as to maintain a one piece, leak proof structure. No brick, stone or concrete block will be used to set the grate to the final grade height. For H-20 load rated installation, an 8” to 10” thick concrete ring will be poured under the grate and frame as recommended by details provided from the manufacturer.

3.9 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318/318R.

3.10 CONNECTIONS

A. Connect non-pressure, gravity-flow drainage piping in building's storm building drains specified in Division 22 Section "Facility Storm Drainage Piping."

3.11 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.
   1. Use warning tape or detectable warning tape over ferrous piping.
   2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.12 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
   1. Submit separate reports for each system inspection.
   2. Defects requiring correction include the following:
      a. Alignment: Less than full diameter of inside of pipe is visible between structures.
      b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
      c. Crushed, broken, cracked, or otherwise damaged piping.
      d. Infiltration: Water leakage into piping.
      e. Exfiltration: Water leakage from or around piping.
   3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
   4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
   1. Do not enclose, cover, or put into service before inspection and approval.
   2. Test completed piping systems according to authorities having jurisdiction.
   3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
   4. Submit separate report for each test.
   5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
      a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
      b. Option: Test plastic piping according to ASTM F 1417.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.13 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with potable water.

END OF SECTION

SECTION 33 46 00

SUBDRAINAGE

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Perforated-wall pipe and fittings.
2. Geotextile filter fabrics.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. HDPE: High-density polyethylene plastic.

C. PE: Polyethylene plastic.

D. PP: Polypropylene plastic.

E. PS: Polystyrene plastic.

F. PVC: Polyvinyl chloride plastic.

G. Subdrainage: Drainage system that collects and removes subsurface or seepage water.

1.4 ACTION SUBMITTALS

A. Product Data:
1. Perforated wall pipe and fittings.
2. Solid wall pipe and fittings.
3. Geotextile filter fabrics.

PART 2 PRODUCTS

2.1 PIPING MATERIALS

A. Refer to Piping Applications Article in Part 3 for applications of pipe, fitting and joining materials.

2.2 PERFORATED-WALL PIPES AND FITTINGS

A. Perforated HDPE Pipe and Fittings:
1. NPS 6 and Smaller: ASTM F 405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
2. Couplings: Manufacturer's standard, band type.

B. Perforated PVC Sewer Pipe and Fittings: ASTM D 2729, bell-and-spigot ends, for loose joints.

2.3 SOLID-WALL PIPES AND FITTINGS

A. HDPE Pipe and Fittings: AASHTO M 294, Type S, corrugated, with smooth waterway, for coupled joints.
1. Couplings: AASHTO M 294, corrugated, band type, matching tubing and fittings.

B. PVC Sewer Pipe and Fittings: ASTM D 3034, SDR 35, bell-and-spigot ends, for gasketed joints.
1. Gaskets: ASTM F 477, elastomeric seal.

2.4 CLEANOUTS

A. Cast-Iron Cleanouts: ASME A112.36.2M; with round-flanged, cast-iron housing; and secured, scoriated, Medium-Duty Loading class, cast-iron cover. Include cast-iron ferrule and countersunk, brass cleanout plug.

B. PVC Cleanouts: ASTM D 3034, PVC cleanout threaded plug and threaded pipe hub.

2.5 SOIL MATERIALS

A. Backfill, drainage course, impervious fill and satisfactory soil materials are specified in Division 31 Section "Earth Moving."

2.6 GEOTEXTILE FILTER FABRICS

A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. when tested according to ASTM D 4491.

B. Structure Type: Nonwoven, needle-punched continuous filament.
1. Survivability: AASHTO M 288 Class 2.
2. Styles: Flat and sock.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.

B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.

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

3.2 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.3 PIPING APPLICATIONS

A. Underground Subdrainage Piping:
1. Perforated HDPE pipe and fittings, couplings, and coupled joints.
2. Perforated PVC sewer pipe and fittings for loose, bell-and-spigot joints.

B. Header Piping:
   1. PVC sewer pipe and fittings, couplings, and coupled joints.

3.4 CLEANOUT APPLICATIONS

A. In Underground Subdrainage Piping:
   1. At Grade in Earth: PVC cleanouts.
   2. At Grade in Paved Areas: Cast-iron cleanouts.

3.5 FOUNDATION DRAINAGE INSTALLATION

A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches deep and 12 inches wide.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.

D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.

E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for foundation subdrainage.

F. Add drainage course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.

G. After satisfactory testing, cover drainage piping to width of at least 6 inches on side away from footing and above top of pipe to within 12 inches of finish grade.

H. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

I. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches.

J. Place initial backfill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

3.6 LANDSCAPING DRAINAGE INSTALLATION

A. Provide trench width to allow installation of drainage conduit. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.

D. Install drainage conduits as indicated in Part 3 "Piping Installation" Article for landscaping subdrainage with horizontal distance of at least 6 inches between conduit and trench walls. Wrap drainage conduits without integral geotextile filter fabric with flat-style geotextile filter fabric before installation. Connect fabric sections with adhesive or tape.

E. Add drainage course to top of drainage conduits.

F. After satisfactory testing, cover drainage conduit to within 12 inches of finish grade.

G. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

H. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches.

I. Fill to Grade: Place satisfactory soil fill material over drainage course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish grade.

3.7 PIPING INSTALLATION

A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.
   1. Foundation Subdrainage: Install piping pitched down in direction of flow; at a minimum slope of 0.5 percent with a minimum cover of 36 inches unless otherwise indicated.
   2. Landscaping Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated.
   3. Lay perforated pipe with perforations down.
   4. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.

B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

C. Install HDPE piping according to ASTM D 2321.

D. Install PVC piping according to ASTM D 2321.

3.8 PIPE JOINT CONSTRUCTION

A. Join perforated, HDPE pipe and fittings with couplings for soil-tight joints according to AASHTO's "Standard Specifications for Highway Bridges," Division II, Section 26.4.2.4, "Joint Properties"; or according to ASTM D 2321.

B. Join PVC pipe and fittings according to ASTM D 3034 with elastomeric seal gaskets according ASTM D 2321.

C. Join perforated PVC pipe and fittings according to ASTM D 2729, with loose bell-and-spigot joints.

D. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.9 CLEANOUT INSTALLATION

A. Comply with requirements for cleanouts specified in Division 33 Section "Storm Utility Drainage Piping."

B. Cleanouts for Foundation and Landscaping Subdrainage:

1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. In paved areas, use NPS 4 cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 24-inch diameter by 8" deep. Set top of cleanout flush with grade. Cast-iron pipe may also be used for cleanouts in non-vehicular traffic areas.
3. In non-paved areas, use NPS 4 PVC pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers with "Concrete Paving." Set top of cleanout plug 1 inch below grade.
4. Comply with requirements for concrete specified in Division 32 Section "Concrete Paving."

3.10 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect low elevations of subdrainage system to solid-wall-piping storm drainage system.

3.11 IDENTIFICATION

A. Arrange for installation of green warning tapes directly over piping. Comply with requirements for underground warning tapes specified in specified in Division 31 Section "Earth Moving."
   1. Install PE warning tape over ferrous piping.
   2. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.12 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.
   2. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

3.13 CLEANING

A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION